ENGINEERING NEWS-RECORD

A Consolidation of Engineering News, Engineering Record, The Sanitary Engineer, and The Contractor

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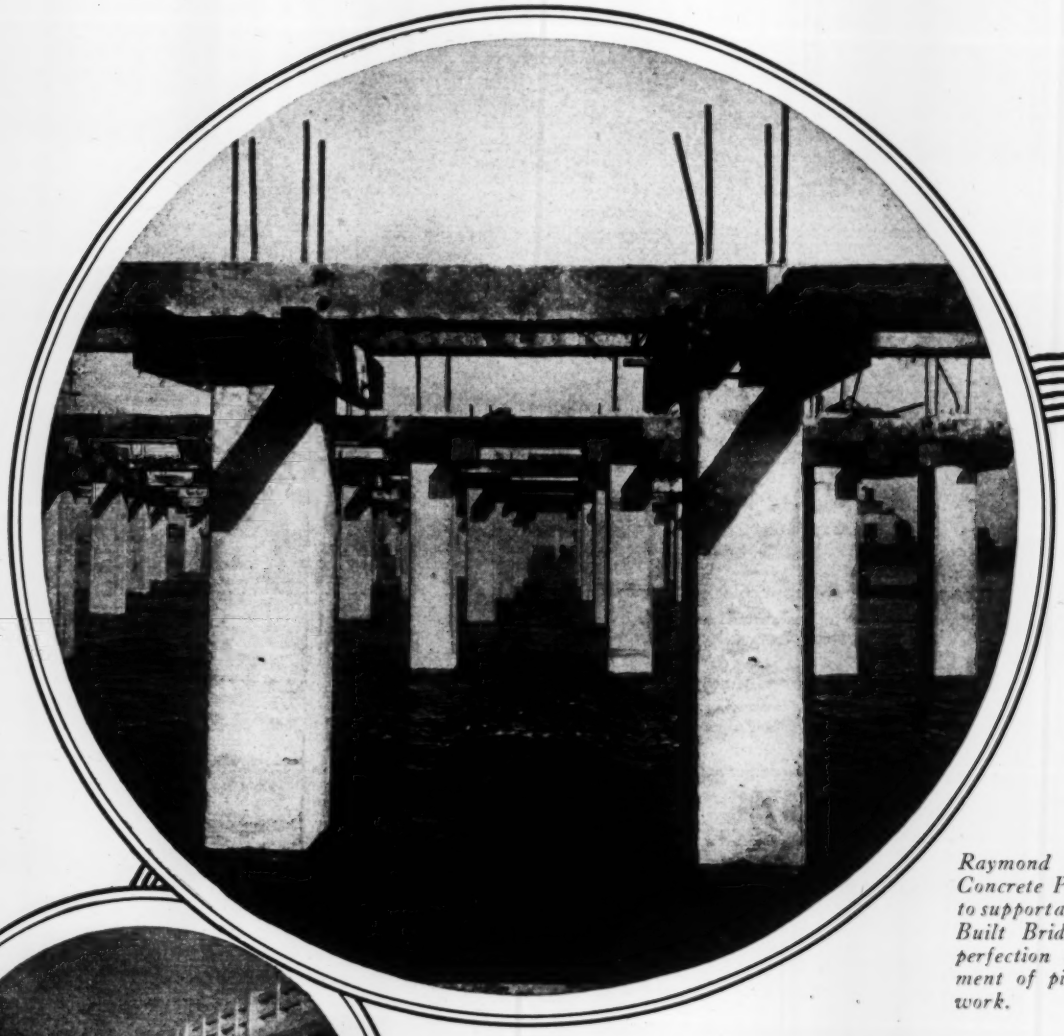
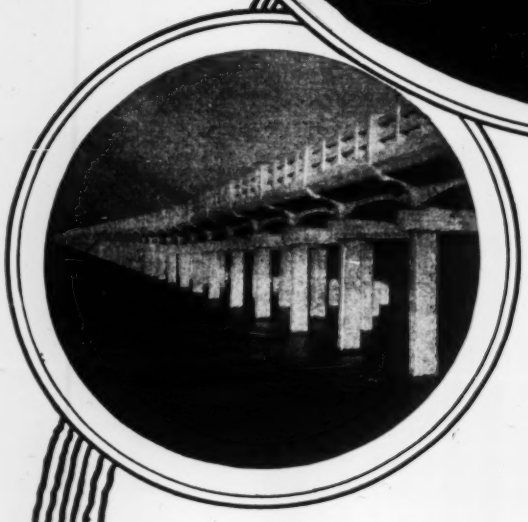
NUMBER OF COPIES PRINTED THIS ISSUE, 32,125





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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 103 | NEW YORK, OCTOBER 3, 1929 | Number 14

Unknowns in Soil Behavior

SOIL occupies the civil engineer's attention and efforts more largely than any other material. Yet, as recent years have shown quite clearly, this material is least explored as to properties and behavior. New testimony to the same effect is contained in a brief note in this issue which directs attention to the great practical meaning of the physical chemistry of soils in certain instances. Studies of some problems which arose in building an earth dam in Hawaii, in loose volcanic soil, led to the discovery that the physical characteristics of the material could be changed surprisingly by very simple chemical treatment—namely, alkalinization. The effect of such treatment was to flocculate particles of the soil, presumably colloidal particles, and thereby convert a loose and unmanageable loam into a quick-settling and impermeable clay. No doubt the action is related to something observed in irrigated agriculture, where certain soils that at first are permeable and arable become tight and useless under irrigation by alkaline waters, due to flocculation of the colloidal particles and sealing of the pores of the soil. That this agricultural phenomenon might have important engineering application does not seem to have been suspected in the past. The Hawaiian discovery, therefore, is of remarkable interest. It opens a wide perspective of possibilities in soil treatment and modification. Above all, it points insistently to the neglect of the physical chemistry of soils in relation to engineering work.

Belts Serve the Contractor

BELT conveyors, long established in industrial and sand and gravel plants, more recently applied to the transportation of earth and concrete, again have shown their possibilities for large-scale earth movements. Their most recent application is found in an ingenious arrangement of a main belt conveyor a half-mile long, fed by six portable systems extending to shovels at all points within the area to be excavated, developed to move more than 4,200,000 cubic yards of excavation through some of Seattle's principal streets in regrading Denny Hill, as described elsewhere in this issue. Closed streets and interference with normal traffic were wisely avoided by elevating the main belt for its entire length. The faith of the contractors in this system is indicated by the fact that they agreed to move the entire yardage in 720 days, or at a rate of nearly 6,000 yards per day, at a unit contract price of 25 cents. In terms of usual haulage methods this represents a daily movement of about 500 construction railroad carloads, or nearly 2,000 truckloads. While conditions on the Denny Hill job are highly favorable to the belt-conveyor method of handling excavated material, yet the success of this operation will undoubtedly prove the possibility of using it in many other situations, such as railroad and highway construction. At any rate, belt conveyors give the excavating contractor a possible weapon to meet the ever-increasing need for lower costs and faster and more efficient methods.

Virtue in Self-Help

EVERYONE knows the old-fashioned virtue of self-help, long famous as the best help, but industries have been slow to apply it. It is therefore gratifying to find that the steel fabricators are about to try self-help as a cure for many ruinous practices which have come to flourish within their industry. Through their national organization, the American Institute of Steel Construction, they have listed the worst of these practices and propose to brand them as unfair, with or without the support of the Federal Trade Commission. The undertaking is hopeful and constructive, because such methods as misrepresentation, substitution, commercial bribery and discrimination are of benefit to none and tend steadily to undermine the technical, financial and personal soundness of the businesses concerned, while also reacting to the disadvantage of the consumer, who is not at all helped by having to deal with an unmoral, disorganized industry. Nor does any single manufacturer really desire to indulge in these practices, for by and large they are resorted to only as means of defense against their real or fancied use by competitors. Self-regulation therefore can make effective headway against them, especially if supplemented by a courageous policy of publicity for violations. The fabricating industry, which has long complained of profitless prosperity due to prevailing unsound practices, has everything to gain through such regulation. The co-operation essential to the attempt should not be impossible to obtain; and once firmly established it may succeed in bringing about other reforms—the production of a single standard series of steel shapes, for example—which will bring further advantage to the engineering world. The present attempt at self-help is an excellent start. May it go forward to success.

Air Traffic Regulation

ANNOUNCEMENT by the U. S. Department of Commerce of a model ordinance for state, county or city regulation of air traffic fills a distinct need at an opportune time. Federal control of aircraft and operators is limited to interstate operation, which leaves a large proportion of air traffic uncontrolled pending state or municipal action. The rapid growth of transportation by air makes it essential that proper safety precautions be enforced regardless of the length of flight; hence the need for action by state and local authorities. The value of uniformity in regulation is beyond question; the history of the automobile shows the harmful effects of conflicting codes. Aviation can avoid this pitfall by taking early action in favor of uniform laws. But it

must seek at the same time to obtain adequate laws. Demand has already sprung up in a number of quarters for more effective control of low flying, of exhaust noise, and other offenses of fliers against the safety or convenience of others. It is for the aviation industry itself to proceed to the control of these abuses if hampering and conflicting laws are to be forestalled.

The Majority Should Rule

SINCE the left turn at street intersections must, by its very nature, interfere somewhat with the even flow of traffic, it is not surprising that efforts to minimize this interference have resulted in a variety of regulations on the subject in different cities. All of these have their advantages and disadvantages, and none offers the perfect solution. More than a year ago the National Conference on Street and Highway Safety, after careful study, adopted as standard the turn from the left traffic lane on the green light, a system which had already attained widespread acceptance and which has, since that time, become almost universal. Unfortunately, however, there are still a few cities, notably Philadelphia and Washington, which refuse to accept the will of the majority, thus creating an entirely unnecessary traffic hazard to the detriment of their own citizens. Violation due to ignorance of the special regulations in these places is bad enough, but is unlikely to result in serious accident because it occurs so frequently that the native driver is prepared for it. Far more dangerous are the unusual maneuvers attempted, from force of habit, by the native driver when he himself becomes a tourist: violations of the established law which find other drivers totally unprepared and which are bound to result in confusion, if not in serious accident. Traffic authorities are striving to reduce traffic accidents; can they consistently ignore this obvious danger? Plausible as may be the argument that "conditions here are different," it cannot outweigh the obvious necessity for uniformity in traffic control.

Why Taxes Rise

TO SUPPORT an argument that government operation is less efficient than private operation, a prominent industrial leader in a recent pamphlet refers to rising taxes as an item of proof. He points to the many complaints about city government and school management, complaints of a kind probably known to nearly every citizen, and then says, "The fact that taxes go up year after year, while the prices of many services decrease as industries increase their efficiency, proves that hard facts justify our chronic political grouch." This one sentence reflects fairly thorough misunderstanding of the great growth of public services, a misunderstanding that is really astonishing when found in a business man of solid practical sense and wide information. One cannot look back even so short a time as a quarter-century—or for that matter a bare ten years—without recognizing the great and continuous extension in public service on the part of our various governmental units. Better water and sewerage, better paving and lighting, street and public building improvements innumerable, formidable traffic-policing operations, schools and health services, rubbish- and street-cleaning activities, have grown quite as rapidly as our living standards or as our industrial efficiency. Nor are these increased public services due to any desire on the part of the officials to magnify the importance of their work; quite the contrary, they are the slow and always inadequate response to rising public demands. Hence our tax rates go up steadily, and there are frequent attempts to devise specific service charges to supplement the general tax income. Every one will admit that taxes are a good and convenient subject for complaint; personally, we like them no better than the gentleman quoted, and we share with him concern over mounting tax rates. But how they can be made to support an argument on the relative merits of private and public operations remains obscure. Light on the subject is needed, but it is not to be obtained through careless assertions.

Beauty as an Ideal

BEAUTY in engineering work—what is it? Publication of the leading products of a recent bridge-design competition suggests the value of reflecting on this question. Whether the architect, old or young, or the artist in any other field will ever be able to bring beauty into engineering construction by conceptions and ideals derived from other activities is not the question now; at all events the imaginative sketches of the young architects who took part in the competition are not a final criterion in this regard.

Going farther back, we are confronted by the fact that the civil engineer's structures have often been called severely plain, and sometimes even ugly. This is in a way natural, for the structures were different from what had gone before, and being different usually entails the penalty of criticism and denunciation. It may be that only a few people really thought the structures were ugly, but when a few called them ugly the term was soon made into a tradition by the many who perceived the structures as something strange. Engineers, having their proper share of inferiority feelings, and perhaps a little more than their share, consequently were often led into attempts at hiding or decorating their structures. So far as we recall this never produced results other than grotesque, and today it is less common than formerly.

In one period it was thought well to beautify an exposed plate-girder by bolting on a few cast-iron rosettes, scattered here and there over the web surface. At other times the forms and proportions of the Greek orders were applied to walls or to chimneys, in the conviction that this would add beauty. Carvings, plaques and lions were more rare, but they also found a place in the beautification work. But in the lapse of time it gradually became the prevailing opinion that this was a poor road to a desirable and appealing esthetic effect. Accordingly the decoration concept has receded to an unobtrusive position.

Later years brought the gradual development of ideas of symmetry, harmony, articulate balance and avoidance of bizarre variations. The mechanism by which this came about worked very slowly and in ways that it is difficult and perhaps unnecessary to attempt to trace. But, to mention one step, it will readily be recalled that the bridge designer who placed a small span of one form directly alongside a large span of another form found it constantly harder to obtain acceptance for his plans or to harmonize them with general taste and concepts of good appearance. We are now approaching, largely because the early efforts at decoration failed so completely, the view that it is best to make an engineering structure look like an engineering structure and not like a frozen forest of palms or the wall of a museum; the view that a structure should express its function, as a whole and in its parts, in order that it may seem what it is and not like something else.

By engraining this view into their design conceptions and working processes throughout, engineers have opportunity to go farther than they yet have done, and in our opinion they can thereby greatly increase the satisfaction which other men feel in engineering works. Architects have meanwhile progressed a slight bit in the same direction, if one may judge from a comparison of modern buildings with those of 30 and 40 years ago—of the Pullman car or United States Post Office era. With his daily training in balance and harmony, the architect can greatly assist the engineer in developing true and efficient forms for his structures. If he will actively supplement the engineer's less perfect perception of these qualities, the joint effort can be fruitful.

Light Structural Shapes

COMMERCIAL production of large structural shapes of aluminum alloy as outlined in this issue represents the most prominent development in the equipment of structural engineering for many years past. Alloys of aluminum have been used for some time in small structural shapes, for aircraft construction and similar special service, but their application in larger dimensions for major structural works has heretofore been impracticable, partly due to a lack of facilities for making such shapes on a commercial basis. The establishment of a rolling mill capable of rolling large shapes therefore opens new possibilities. It comes at a time when many trends in the structural art are pointed toward weight-efficiency and weight saving—that is, higher ratio of strength to weight.

Among the significant movements of recent years is the slow but steadily advancing use of alloy steels in structures. Long-span bridges created the introductory demand, even in the classical case of the Eads bridge with its chrome-steel arch-tube staves and more definitely so in the later nickel-steel bridge trusses and the still later silicon-steel members and tempered eyebars. In this field reduced dead-weight justifies itself so pre-eminently that the value of a strong though costly material is clear. But even for buildings the strong steels have been found economical, and if only occasional applications have been made the reason lies in the unreadiness of furnaces and mills to adjust their large-scale production systems to the new demand, rather than in lack of economy or suitability. Alloy steels will extend in use when once this obstacle is overcome.

A related movement is the sensational growth in popularity of the suspension bridge type in recent years, for the type in conjunction with the very high strength of cable wire leads to great reduction in the weight of material required. Efforts made in late years to develop lighter bridge floors—hitherto the point at which reduction of dead-load seemed to be halted—are further evidence of the pressure of practical demand for light structures.

In the meantime airships have built up a great industry, founded throughout on the ideal of greatest strength with least weight. Both steel and wood made and kept a place for themselves in this field, but almost from the start aluminum alloys have been the leading contenders in the race. Manufacturing technology and engineering technique in this material have been advancing continuously, and in this progress its growing claim to a place in the general structural field has become apparent. Moving structures, where weight means the daily cost of operating power, are naturally first in line; hence railway car and automobile frames, and now also several traveling cranes built of aluminum alloy. If these services find merit in the new material, it is certain that there will be occasional, perhaps more than occasional, opportunity to apply it in fixed structures.

With the commercial advent of shapes large enough for a wide range of structural needs these possibilities become concrete. Structural engineering is perhaps less ready for its part in realizing them, being unskilled in the methods of connection, proportioning and other phases of practical construction. Some extensive test investigations now under way promise to supply this want of skill, and it is hoped that their results may soon become available. Even without them, however, enough has been done to show that no major difficulties stand in the way of the application of these alloys to structures. Accordingly we are in the opening days of a promising development in technical practice. Its future course is well worth watching.

Architects and Engineers

REVERSAL of a lower court decision which declared the New York State multiple-dwelling law unconstitutional restores that law to full effect and again opens up a question which has given much concern to engineers of the state, chiefly to those of New York City, the only place where the law is applicable. Plans for buildings under this law may be filed only by the owner or an architect. No provision is made for the filing of plans by engineers, and many engineers, notably those whose chief occupation is in building reconstruction work, see in this a degradation of the engineer to the status of a subordinate of the architect.

But is this a correct view of the situation? Is it not rather that the prime responsibility for building construction rests upon the architect of the structure and that the law cannot make a fine distinction between architects' and engineers' work where they are so closely integrated as they are in building construction? Building laws and architects' and engineers' license laws are written to protect the public, and responsibility must therefore be clearly defined. If, therefore, an engineer does work which the law recognizes as being in the field of architecture under the very broad terms in which the architects' license law defines practicing as an architect, his professional standing should in no way be affected by a requirement that an architect must vouch for his work.

The architects' license law defines an architect as "one who designs plans for structures and supervises their construction," and the engineers' license law defines an engineer as "one who holds himself out as able to do, or who does, the work that an engineer does in the planning, designing, constructing, inspecting and supervising of engineering works, or appliances involved in public or private projects, or in making investigations for proposed engineering projects." Consequently, while a law such as the multiple-dwelling law may well fix the responsibility directly upon the architect, the engineers' license law clearly requires that the engineering work in connection with his buildings be done by or approved by a licensed engineer. Obviously, therefore, it would be futile for any law to attempt to define where the architect's work leaves off and the engineer's begins. Responsibility for that rests upon the architects and engineers themselves. Neither profession is degraded by having to ask the other to approve certain details of its work in large building construction.

Design of a Modern Cold Storage Warehouse

Latest Developments in Machinery and Insulation Used in New Eight-Story Philadelphia Plant of the Pennsylvania Railroad—Superstructure Completed in Four Months

By F. O. Dufour

Consulting Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

AS AN EXTENSION to the development of a produce terminal adequate to serve the city of Philadelphia, the Pennsylvania Railroad last year completed an eight-story reinforced-concrete perishable produce warehouse, employing the most modern principles of cold storage. The structure, situated at Oregon and Delaware Aves., covers an area 112x255 ft.; has a gross cubage of 3,812,000 cu.ft., and with a net storage volume of over 2,000,000 cu.ft. has space for 1,300 carloads of produce. Loading platforms are located on both sides of the building, with two railroad sidings at each platform. Facilities provide for handling 50 to 60 cars of produce in and out daily.

The building consists of eight floors and basement, with a first-story height of 20 ft. 10 in. and the remaining stories with a height of 12 ft. clear. The first floor contains offices, weighing, inspection, loading spaces and the machinery room, and the upper seven floors are delegated to cold storage space exclusively. The structure has reinforced-concrete frame and floors throughout, the concrete spandrel beams supporting the outside brick walls. The walls of the first story are concrete, but above the second floor level the walls are brick with no concrete exposed. A hard shale brick with a Harvard range of colors was used, ornamented at the coping with buff terra cotta.

The columns and the 10-in. floor slabs (thickness exclusive of wearing surface and insulation), designed for a live load of 250 lb. per sq.ft., were erected independently of the outside walls and columns, allowing room for corkboard insulation between the outside shell and the interior structure. The elevator and piping shafts were also built independently of the floor slabs and are entirely insulated with cork.

Four elevators of 5,000-lb. capacity, each with automatic floor-finding and self-leveling devices, serve the warehouse. Flexible rubber strips on the sides, top and bottom of the elevator cars are in contact with wood strips on the inside face of the elevator walls, thus enabling the cars to form an air lock at each cold-storage floor when the refrigerator doors are opened. In older warehouses, where this is not done, cold air is lost from the rooms, which causes the moisture in the warmer air of the shaft to condense and "rain," and as a result the shafts are always wet.

FIG. 1—MODERN EIGHT-STORY REINFORCED-CONCRETE COLD STORAGE WAREHOUSE BUILT BY PENNSYLVANIA RAILROAD, PHILADELPHIA

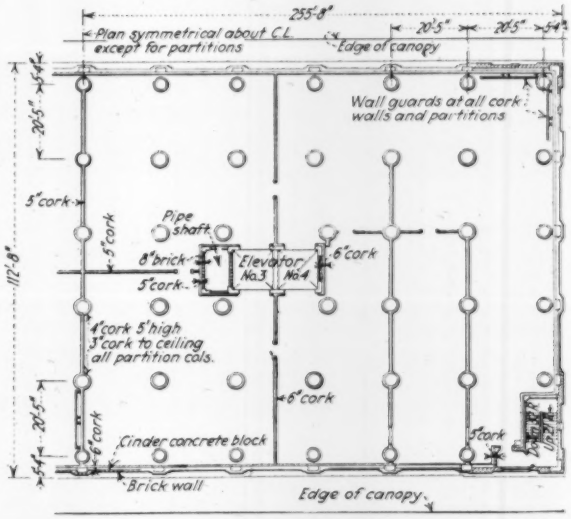


FIG. 2—PART OF SECOND FLOOR PLAN, P.R.R. COLD STORAGE WAREHOUSE

First floor contains offices, inspection and weighing facilities and refrigeration machine room. Remaining floors devoted to cold storage. Upper floors similar to second floor plan except for insulation details.

The foundation of the building is a mat of reinforced concrete 3 to 3½ ft. thick, resting on about 5,000 wood piles, distributed over the entire foundation area. This foundation was completed early in May, 1928, and the formwork on the superstructure was started immediately, the first concrete being poured May 10. The mixing plant consisted of a 1-yd. mixer with automatic weighing bins and an inundator system. The concrete was distributed by a steel mast hoist and chutes. Concreting operations started in earnest on May 21, and July 19, 1928, the entire structure, containing over 13,500 cu.yd. of concrete, had been poured. More than 1,000 tons of

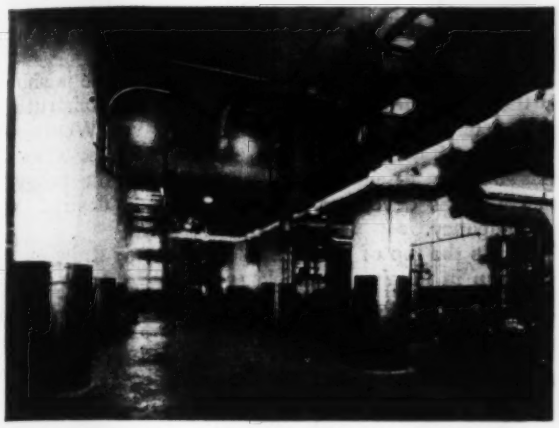


FIG. 3—REFRIGERATION MACHINE ROOM

reinforcing steel was used in the building. A total of more than 1,000 cars of building material was used in the construction operations, all delivered to sidings at the site. A maximum of 80 cars was delivered and unloaded in one day.

All floors were laid, walls plastered and painted, doors hung and rooms cooled to proper temperature, so that produce could be received by Sept. 10, 1928, exactly four months from the day the first concrete was poured in the superstructure.

The entire area of the building is protected with a sprinkler system, using as extinguishing fluid a calcium chloride solution having the same density as the brine in the refrigerator system. The brine in this system is separated from the clear water in the city mains by a deluge valve which opens in case of fire and allows the system then to be fed with city water for fire apparatus. The system can be drained of water and recharged with calcium chloride after such use.

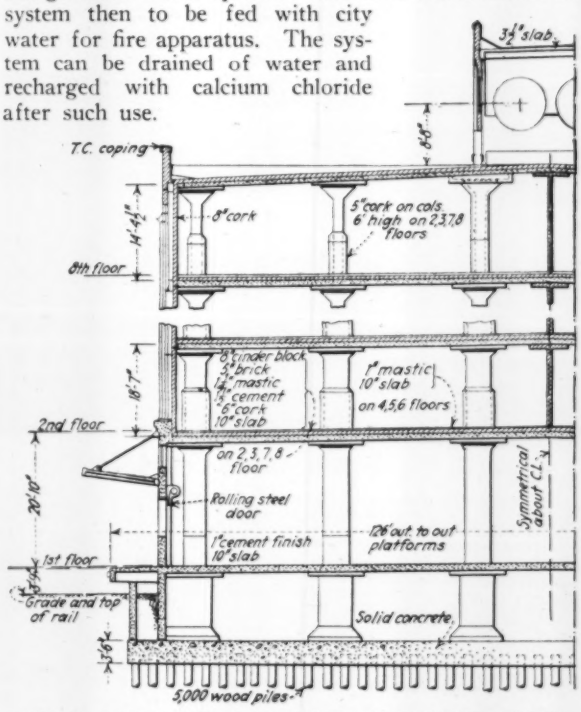


FIG. 4—PART OF CROSS-SECTION OF BUILDING FROM SOUTH END LOOKING NORTH

Outside walls, elevator and pipe shafts built independent of floor system to permit thorough insulation. All walls, roof and slabs on second, third, seventh and eighth floors covered with cork insulation.

The rooms in the cold storage portion of the house are so arranged and so connected that two of the seven floors may be operated as either cooler or freezer floors and the five other floors as cooler floors, which makes the house very flexible as to type of storage required. The third floor is insulated to allow for storage of commodities on the second floor requiring higher temperatures than needed for fruits or produce. This required cork insulation on four floors, the roof and all walls.

The refrigerating machinery consists of one ammonia compressor of 17- to 25-ton capacity and three large machines of a rated capacity of 75 to 125 tons, the capacity depending upon operating conditions. These machines are arranged in booster fashion, in that through a system of headers they can be arranged to operate in either single or double stage. Each compressor is equipped with capacity reduction valves so that they may be operated at reduced volumetric capacity, which is expected to be a large factor in economical operation.

All of the machinery is electrically driven, power being furnished by a main service and an emergency circuit.

The ammonia after being compressed is passed through a bank of eight multi-tube seven-pass condensers rated

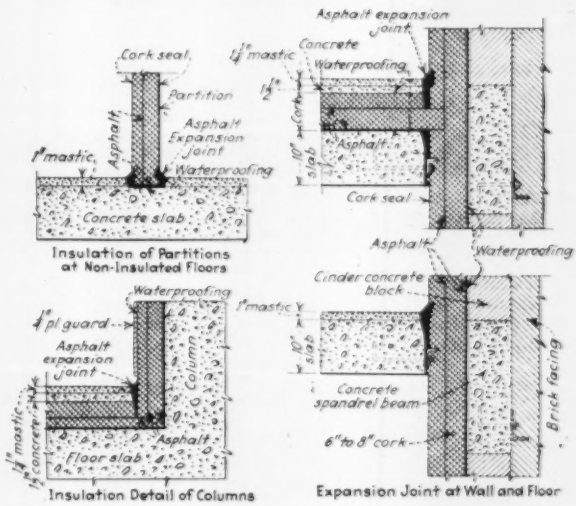


FIG. 5—DETAILS OF INSULATION AT WALL AND FLOOR JOINTS

at 37½ tons of refrigeration each. These condensers are normally fed with cooling water from two wells, but an emergency connection is provided so that the city water may be used to operate the condensers.

After the ammonia condenses to a liquid at approximately 75 deg. F., it is collected in a liquid receiver and passed through a liquid precooler which reduces the temperature several degrees and assures that no gaseous ammonia is left in the lines. From the precooler the ammonia is passed through a recording Venturi tube, and thence to an expansion cooler, controlled by a float valve, where a portion of the liquid to be used for low-temperature work is cooled to approximately 10 deg. F., while the remainder, to be used for high-temperature brine, is bypassed, and both are then sent to brine coolers.

Three brine coolers are installed, each connected to a system of headers, so that any one of them may be operated on either a low- or a high-temperature brine system. Float controls and suction traps are arranged on the ammonia lines so that when operating on either low- or high-temperature work the expansion of the ammonia is

controlled automatically and the liquid is sent through the brine coolers and returned to the compressor through individual suction lines. There is also a brine-mixing tank piped to the outside of the building, with tank-car connections, and a brine make-up pump for charging the system.

The calcium chloride brine, after being cooled in the brine coolers, is also divided into two temperature systems, working at +10 and —20 deg. F. respectively, circulated by four circulating pumps and equalized at the top of each system by a balance tank above the roof of the main building.

In direct charge of the building for the Pennsylvania Railroad were T. J. Skillman, chief engineer of the system, and E. B. Temple, chief engineer of the Eastern region. The building has been leased from the railroad by the General Cold Storage Company, George L. Morrison, president. It was designed and built by the United Engineers & Constructors, Inc., of Philadelphia.

Scheduling Materials Purchases in Building Work

By Simple Symbolizing, Price Taking, Purchasing and Start and Completion of Deliveries Are Recorded on One Date Chart

By G. W. Maker
Engineer, Morton C. Tuttle Company, Boston, Mass.

A Purchasing and a materials delivery schedule is as important in directing construction as is a progress schedule. This is particularly true of building where many kinds of materials and many different trades enter into the work in definite sequence. The method of charting purchases and deliveries described here is notable for its simplicity and its direct tie-in with the progress schedule.—Editor.

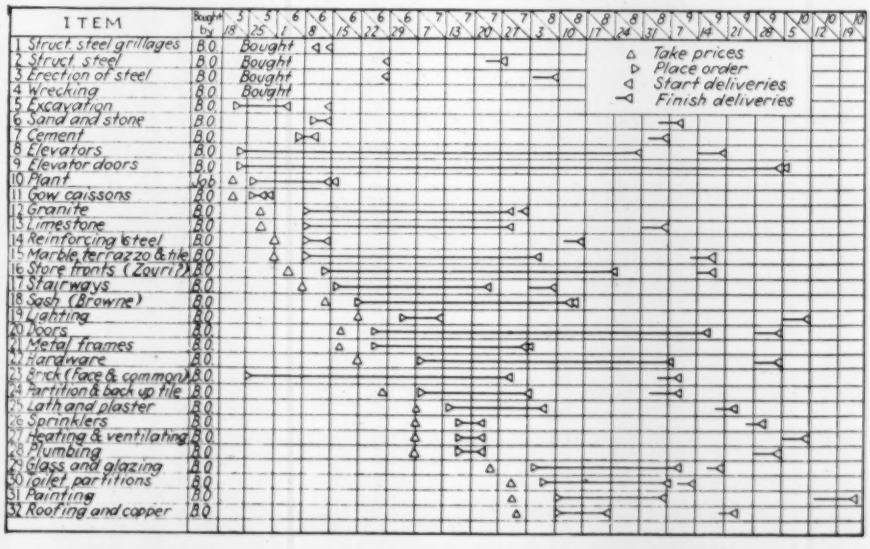
SYSTEMATIC buying for a construction operation is an important correlative of time scheduling. As a matter of fact, the key point of the progress schedule is very frequently the delivery date of one of the major items of material, with the result that in the preliminary consideration of the starting date, the purchasing and time schedules are interdependent. Even throughout the life of the contract they are so closely tied together that anything but constant attention to delivery dates of materials and starting dates of subcontracts will seriously affect the progress of the job.

In the writer's company the first step following the closing of a contract is the preparation of the progress schedule in which the starting and completion dates of each major operation or subcontract is graphically shown on a special printed form. With this chart before him, the purchasing agent lays out his buying schedule in similar form and, with the co-operation of the construction manager, charts the date when prices must be taken and orders placed to insure delivery at the time required by the progress schedule.

An example of a buying schedule now in use is shown by the accompanying diagram covering the construction of a retail store building for the F. W. Woolworth Company at Boston, Mass. In this particular instance time was the essence of the contract and the progress schedule was developed backward from a desired date of occupancy.

Across the top of the schedule the life of the contract is shown in number of weeks, these dates being copied from the progress schedule. The items in the first column are also taken directly from the progress schedule. The second column is intended to show which orders are to be placed by the company's main office (B.O.) and which by the field office (Job). Since this is a local contract, as a matter of economy the field organization is not planned to include purchasing, practically all of which is done at the company's main office near by. In the case of a distant contract, the schedule would show much of the purchasing in the hands of the field organization under the general supervision of the main office purchasing department and construction manager, particularly as regards major items.

The follow-up of the schedule is left to the field office, which is fully informed of terms of purchase, delivery dates, etc., through copies of orders sent to the job at the time orders are placed. This procedure is more practical than is follow-up by the main office, as any variations in progress schedule which might affect deliveries or start of subcontract originate in the field and unless such variations are of major importance they are not given particular attention by the main office.



EXAMPLE OF MATERIALS PURCHASE AND DELIVERY CHART FOR BUILDING CONSTRUCTION

Vermont Expenditures Increased by Flood

Damage resulting from the flood of November, 1927, in Vermont is reflected in the expenditures of the general departments of the state as reported for the year 1928 by the U. S. Department of Commerce. Per capita cost for the operation and maintenance of general departments was $9.36 in 1918, $13.93 in 1927 and $18.06 in 1928. The total amount expended for operation and maintenance was $6,365,784.

FIFTH AVENUE FACE OF DENNY HILL
Maximum cut height, 89 ft. Movable conveyor units along the street.

Belt Conveyors Remove Denny Hill, Seattle

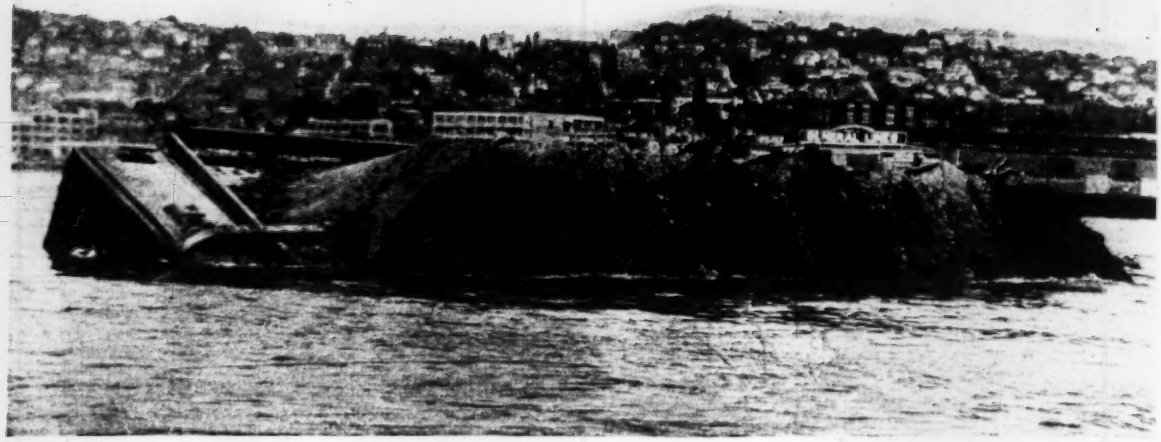
This 4,223,000-Cu.Yd. Obstruction to Traffic and Impediment to Expansion of Business District Being Leveled by a ½-Mile Conveyor System, With Movable Feeder Belts a Feature

FOR the second time Seattle has attacked the eminence in the northern part of the city known as Denny Hill, which long has been an obstruction to traffic and to the expansion of the business district in a northerly direction. This time a total of 4,223,000 cu.yd. of material is to be moved from 32 city blocks on which the ground level is above the grades prescribed for city streets. The maximum depth of cut will be 89 ft. The 2,700,000 cu.yd. to be removed from streets, alleys and slopes is to be paid for with funds obtained from an assessment district, and owners of 92 per cent of the private property involved have agreed to pay 25c. per cubic yard for material taken from their lots. The total yardage on private property is 1,523,000 cu.yd. On Sept. 14, 1928, the city awarded a contract for removing the entire hill at the rate of 25c. per cubic yard under terms requiring the work to be completed in 720 days from the date of the award. In the earlier Denny Hill project, carried out in 1909, hydraulic sluicing methods were used, as described in *Engineering News*, March 31, 1910, p. 355.

The plan adopted for handling the material under the present contract was to move it on belt conveyors from the point of excavation to the waterfront and there deliver to barges that dump in deep water in Puget Sound. A point was selected in the regrade district located centrally with respect to the total yardage to be moved, which would serve as a central collection depot or loading point. From this center to the waterfront an elevated timber structure was built to house the main conveyor belt. Under this plan all conveyors operating outside the area actually being regraded would be above street level, avoiding practically all interference with street traffic. Excavation is done exclusively with electrically operated power shovels which deliver to hoppers over conveyor units mounted on skids for convenience in shifting over the job as the work progresses. These movable units all deliver to the upper end of the main conveyor system.

On this plan of operation, the line of movable conveyors and the power shovels that serve them will rotate around the central point where delivery to the permanently located conveyor belt is made. At the start the movable conveyor units were stretched out along

ELEVATED BELT CONVEYOR STRUCTURE
Note trusses across streets. One side of housing was boarded up to prevent dust nuisance.



LOADED BARGE DUMPING IN HARBOR
Deep water affords short haul. Barges are reversible, turningover automatically when seacocks are opened to unbalance load.

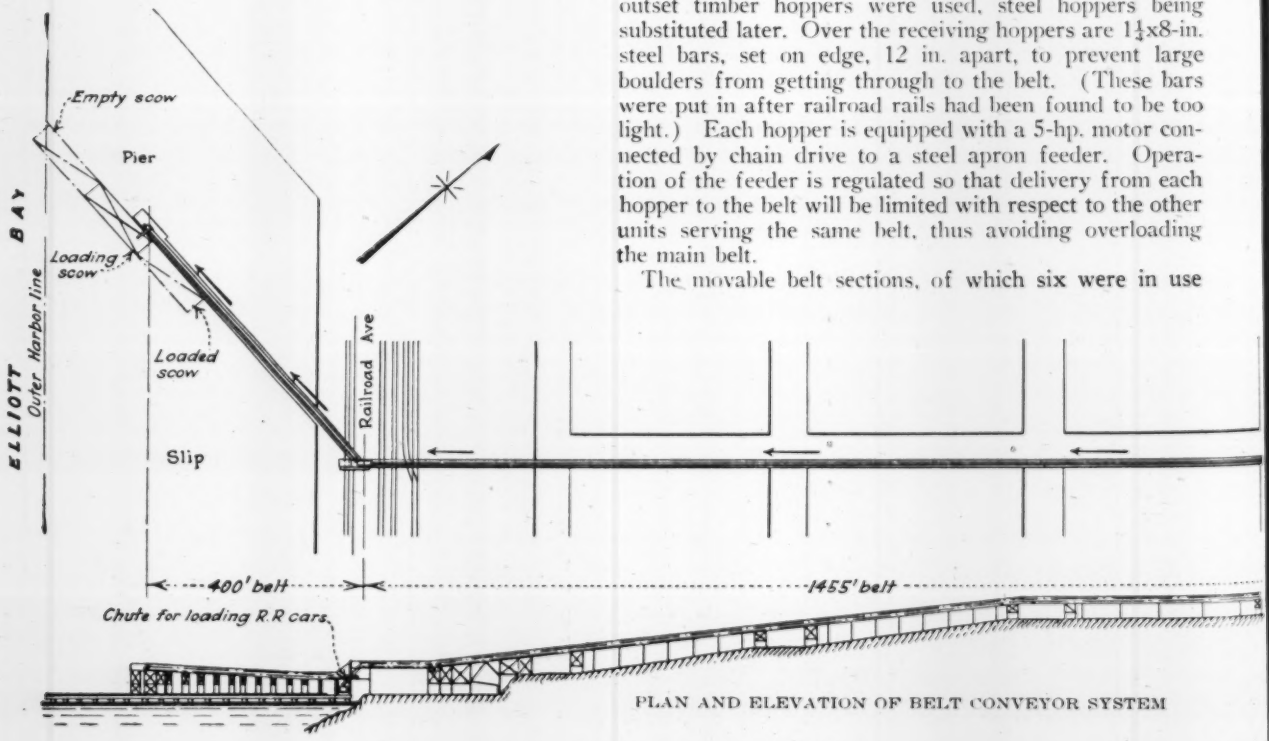
Fifth Ave. to the south of the main conveyor belt. The line of conveyors along Fifth Ave. and the operations in bench cuts at higher levels will swing gradually east as the work progresses and ultimately around to the north. The bench cuts at higher levels will be made by the same methods used at street level and will deliver to the same point on the main conveyor system, the bench operations merely adding more faces along which the work may be advanced.

The material to be handled, in so far as has been indicated by exploration, ranges from wet sand to hardpan containing considerable blue clay. Some boulders have been encountered, and these are removed by a separate crew as soon as they are unearthed. Bulldozing is done when necessary; specifications for delivery to the main belt require the material to pass through a grillage in which the bars are spaced 12 in. apart.

Excavation will be carried on both along the working face at street level, which at the outset extended along Fifth Ave. to the south of the main belt, and also at benches cut at higher levels. Four shovels with 2-cu.yd. dippers and two with 1½-cu.yd. dippers will be operating when the work is at its height. The movable belt conveyors will be kept fairly close to the shovels, so that the swing of the dipper sticks from face to belt will be less than 90 deg.

Dippers discharge into receiving hoppers mounted on double-flanged wheels which run on timbers laid on the skids extending from under the belt conveyors. At the outset timber hoppers were used, steel hoppers being substituted later. Over the receiving hoppers are 1¼x8-in. steel bars, set on edge, 12 in. apart, to prevent large boulders from getting through to the belt. (These bars were put in after railroad rails had been found to be too light.) Each hopper is equipped with a 5-hp. motor connected by chain drive to a steel apron feeder. Operation of the feeder is regulated so that delivery from each hopper to the belt will be limited with respect to the other units serving the same belt, thus avoiding overloading the main belt.

The movable belt sections, of which six were in use



PLAN AND ELEVATION OF BELT CONVEYOR SYSTEM

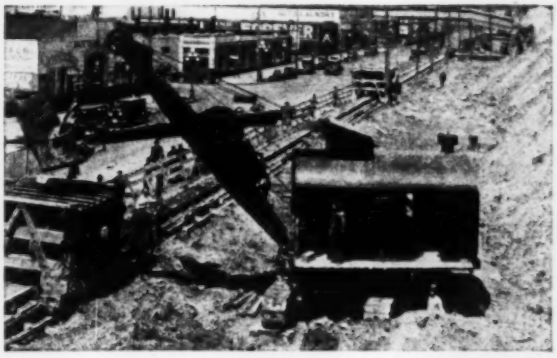
when the work began, are each 250 ft. long and are interchangeable units in all respects. Motive power for each section is supplied by a 20-hp. motor. At each junction point between the 250-ft. units the delivery end of the belt is elevated so that material may be dropped onto the next succeeding unit. At these junction points sideboards lined with steel plates are built up to prevent spillage.

No difficulty has been found in operating with the conveyors on an angle at the junction point between them and thus the units can be moved as often as may be desirable to keep the belts in the most effective location. The belt capacity in both the fixed and the movable system is the same, ranging from 500 to 600 cu.yd. per hour, according to the loading. Belts mounted on skids are 30 in. wide and all others are 36 in. wide. The movable belt sections operate at a speed of 400 ft. per minute, and the fixed belt speeds are 600 ft. per minute.

For approximately half a mile the main or fixed belt system is carried in an elevated timber structure with a clearance of 18 ft. above street level. There are eight street crossings over which the elevated structure is carried on timber trusses, the maximum span being 72 ft. Ample space is provided within the elevated housing to give access to both sides of the belt, and there is a 3-ft. walkway on either side. On both sides of the housing 2-in. planking was carried up above belt level to reduce risk to persons and property below from fragments that might be dislodged from the belt. Since the prevailing winds in the summertime are from the southwest, the south side of the housing was entirely boarded up to prevent dust nuisance.

The spot which later will be the intersection of Sixth Ave. and Battery St. is the central point about which the movable belt system will be swung as excavation advances, and here the entire yardage will be transferred from movable units to the main belt. From this point the main belt line starts up an incline to reach the height needed for street clearance. The first section of the main belt system extends from the central loading point to Third Ave. and is 943 ft. long. It is operated by a 100-hp. motor, which gives a capacity 33 per cent greater than the maximum expected load so as to take care of any momentary overloads that might occur.

At the outset the transfer of material from one belt section to another in the elevated structure was accomplished by dropping it through the usual steel-lined chute, a rubber belt lining being used to muffle the noise because the Third Ave. transfer point is in a residential district. Later, when wet material was being handled, the arrangement was changed to provide for dropping material from one belt directly onto the other.

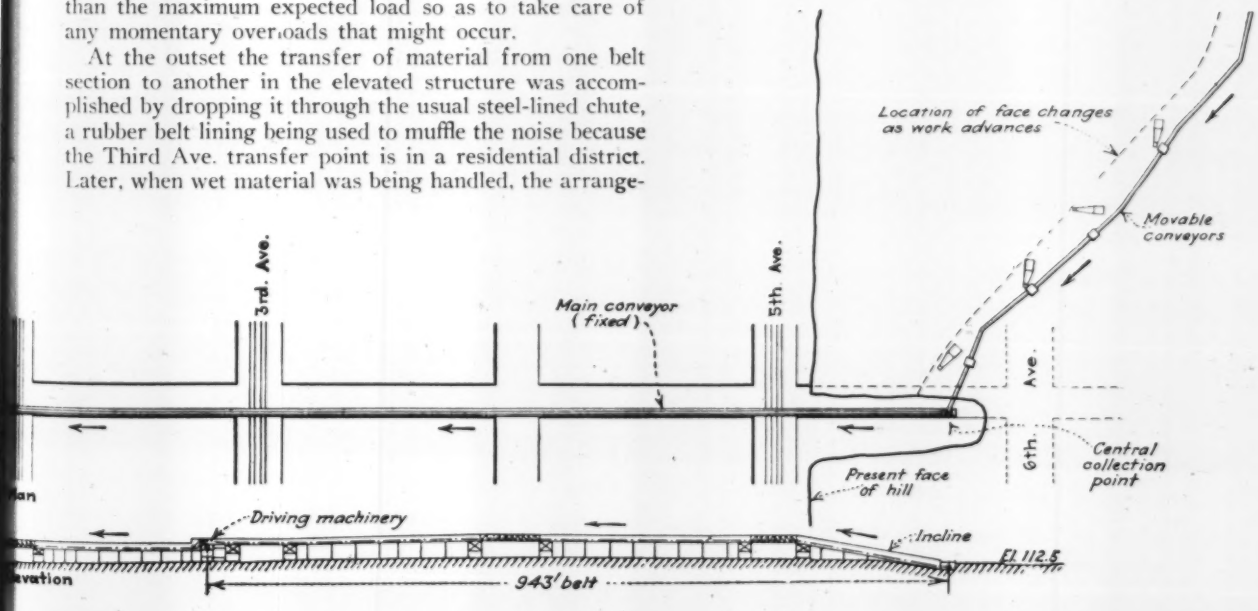


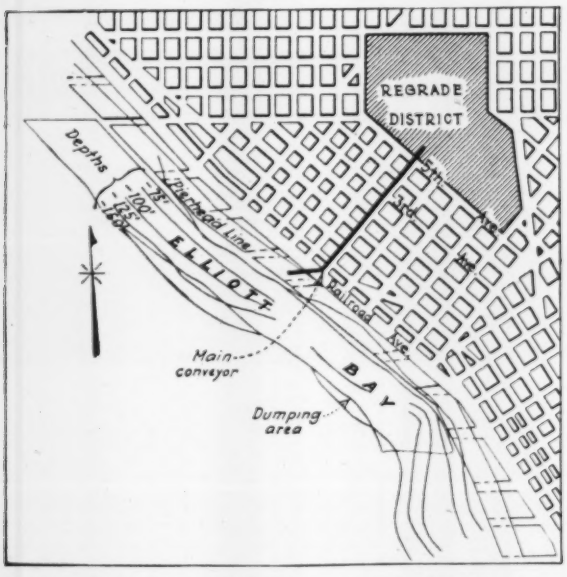
TWO-YARD ELECTRIC SHOVEL DELIVERING TO HOPPER

Hopper is shifted along belt when shovel advances. Belt units are moved sideways to follow face of cut. Elevated belt housing in background.

The next lower section of the main belt, extending from Third Ave. to Railroad Ave., is 1,455 ft. long and is operated (also with 33 per cent excess capacity) by a 50-hp. motor. The smaller motor is suitable because this section has no lift; on the contrary, its lower portion is on a downgrade. When this belt is fully loaded, its motor tends to operate as a generator and really functions as a brake. A solenoid brake is provided on this motor so the belt may be stopped and held in case it is necessary to shut down while there is load only on the inclined portion of the belt. This feature is also a safety measure to hold the belt if the power should suddenly fail while the belt was loaded. In both these long sections of the main belt compensation for slack is made by a counterweighted automatic take-up hung in a vertical position with a travel of 15 to 30 ft. designed to maintain at all times a uniform tension on the belts.

From Railroad Ave. to the point of discharge out on the pier a 400-ft. length of belt is operated by a 30-hp.





KEY MAP, DENNY HILL REGRADE PROJECT

motor. From this discharge end of the belt the material falls into the chute leading directly to barges floating alongside the pier. Electrical control for the various motors operating the belts has been worked out so that when any belt in the system is stopped, all belts behind the one stopped by the operator will automatically stop at once. For example, if the belt at the waterfront is stopped by the operator at that point, all belts stop immediately (including those in the movable belt sections). They are restarted in sequence by a signal system beginning with the belt nearest the discharge end. This is to avoid any danger of "floating" or overloading.

In the long fixed belt section, driven by the 100-hp. motor, wear on the belt fabric due to the drive mechanism has been reduced by a "hugger drive" or pressure belt. This auxiliary belt presses the main conveyor belt against the drive pulley so as to ease the initial tension upon it.

In case it should be decided later to use some part of the spoil for fills along the waterfront, a chute has been built at the shore end of the pier which could discharge into dump cars on the railroad track passing beneath the elevated structure at this point.

The slope of the harbor bottom along Seattle's waterfront is steep and deep water may be reached by only very short hauls from the pier. The contractors are free to dump barges at any point within prescribed limits outside the pierhead lines with the proviso that the bottom will not at any point be brought above a depth, at low tide, of 64 ft.

The barges are of the automatic dumping type, described in *Engineering News-Record*, Sept. 27, 1928, p. 480. They are built of wood, with a deck size of 100x34 ft. over all and a 9½-ft. center depth. They are designed to carry 400 cu.yd. of material on the estimate that the spoil will weigh approximately 3,000 lb. per cubic yard. The seacocks opening into the eccentric tanks which provide the unbalanced loading for overturning are of such size that when the inlets are opened on a loading barge only three minutes is required for the tanks to take in enough water to cause overturning. Freed of its load of earth, the overturned barge rises to a height such that the water in the eccentric tanks will drain out by gravity in a period of eight minutes. The barge is then ready for loading on the newly upturned side and this load is later dumped by another overturning accomplished in a similar manner.

The Denny Hill project is being carried on under the direction of W. D. Barkhuff, city engineer. The general contract is held by George Nelson & Company, of Seattle, by which the excavation was sublet to Copenhagen Bros., Portland, and to the Nevada Contracting Company, Fallon, Nev. The conveyor belt system is equipped throughout with belt rolls having roller bearings mounted so as to be easily accessible for repairs and greasing. The conveyor belt system and feeders from hoppers serving the portable belts were designed and furnished by the Link-Belt Company.

Rockfill Dam on Virgin River, Nev., Washed Out During Construction

A ROCKFILL dam that was being built in a narrow canyon of the Virgin River, a tributary of the Colorado River entering that stream from the north near the Boulder Canyon dam site, was breached by impounded waters that burst through the structure in July before the dam was completed. No statement could be obtained from officials of the company owning the dam and the following information was secured chiefly from those who were sufficiently interested to visit the site after the accident.

The structure was being built for a realty and development company under plans contemplating a rockfill 120 ft. high located in a narrow box canyon whose walls rise almost vertically from water level for a distance considerably greater than the proposed height of the dam. Preliminary exploration of the foundation is reported to have found no bedrock up to depths of 80 ft. below streambed.

The method of construction employed at the outset was to tunnel the canyon walls somewhat above the elevation of the dam crest and to blast the rock into the gorge. Of the rock thus thrown into the river in the early stages of the work a considerable quantity was in very large blocks which buried themselves in the detritus of the streambed. Later the fill was continued with power shovels loading rock into trucks, which dumped it over the crest of the advancing fill, the work progressing from one side of the stream. In this way a fill was built up with very steep sides, the slope being somewhere near the angle of repose, perhaps as steep as 1 : 1. No information is available as to what endeavor was made to make the fill itself tight and compact or to what extent there was attempt to secure an effective cutoff in the streambed.

According to those at the dam when the break occurred, the fill was not overtopped. When the head behind the dam reached a high level (65 ft., according to one informant), seepage through the dam became so rapid that a large slide on the lower slope occurred and thereafter disintegration of the fill continued rapidly. Within an hour and a half almost the entire fill had been swept downstream.

Water Conservation in Prussia

Every bathtub has been sealed with lead and made unusable in Aix-la-Chapelle, Prussia, as an emergency water-conservation measure. Garage water connections have also been sealed and the water tax has been raised to 25c. per cubic meter.

Rapid Erection of Chicago Bascule Bridge in Emergency

Co-ordination and Systematic Organization of Forces Made Opening Possible in 47 Days

IN BUILDING the new double-leaf bascule bridge over the Chicago River at Clark St., it was planned to maintain the old swing bridge in service until the completion of the new bridge in October, 1929, but this plan was upset when a steamer knocked the old bridge off its turntable on April 29. After considering the time and expense of restoring the old bridge to service, the city's engineers decided that it would be better to speed up the erection of the new structure. This was done so effectively that the bridge was opened for street cars and pedestrians on June 27, or in 47 working days. To accomplish this, the work was handled by one shift of about 100 men working twelve hours daily, including Saturdays and Sundays. The roadway paving, railings and permanent sidewalks were completed later.

At the time of the accident, steel erection and machinery placing had been begun at the south end, but not at the north end. The work of lhe 47-day period included the erection and riveting of about 1,800 tons of structural steel and 200 tons of machinery; also painting the steel, placing the deck and paving and pouring 643 cu.yd. of concrete for the counterweights. In addition, the old swing bridge was cut apart with torches and removed, miscellaneous steel was placed and concrete decks were laid on the steelwork of the approaches. For these decks special cement was used, to permit putting them into service in 24 hours.

Two important items in promoting this rapid work were complete co-ordination between the city's engineers and the contractor's staff and systematic organization of the office and field forces of the contractor. As there was little space available for storage at the site, the steel and other materials had to be delivered almost as required for use. Steel and machinery were shipped by rail to the Erie Railroad landing on the Chicago River at Eighteenth St., where the cars were run onto car-ferry barges and towed to the site. The main erection equipment consisted of one 50-ton stiff-leg derrick on each side of the river, with one scow derrick to transfer materials across the river, to unload the cars and to assist the main derricks in placing the heavier members. The heaviest pieces handled were the four 47-ton curved plate girders supporting the inside ends of the main trunnions.

This bridge, 245 ft. c. to c. of trunnions, has a 38-ft. roadway with two street-car tracks, and two 13-ft. sidewalks outside of the trusses. Each leaf is operated by two 75-hp. electric motors. Its construction was under the direction of Loran D. Gayton, city engineer, and Major Paul Schioler, city bridge engineer. The fabricated steel was furnished by the American Bridge Company to the Ketler-Elliott Company, which was the general contractor and whose president, A. C. Ketler, was in personal charge of the rapid erection work.

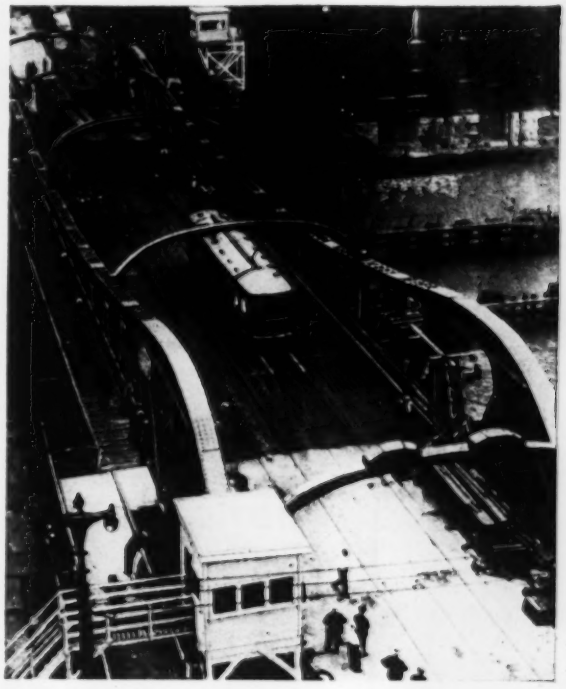


FIG. 2—NEW BASCULE BRIDGE AT CLARK ST.
Opened to traffic June 27, or 47 days after accident to old bridge.

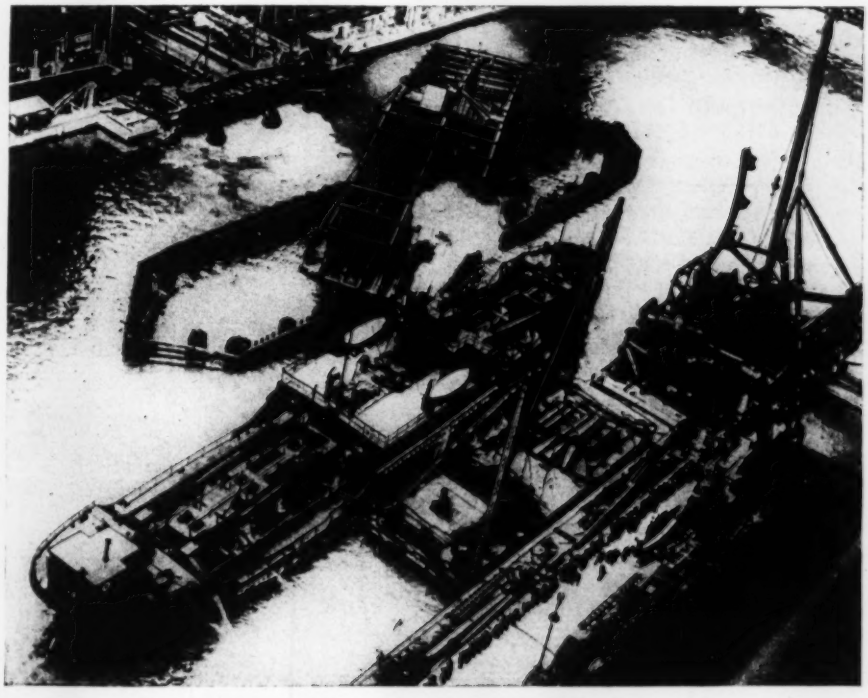


FIG. 1—ACCIDENT TO CHICAGO SWING BRIDGE
Steamer knocked old Clark St. swing span off its turntable just after erection of new bascule span was begun, April 29, 1929. Note small amount of steel in place for new bridge.

Progress of Sewage Treatment in North America

Concise Summary of Observations on Oil-and-Grease Troubles, Tank Treatment, Sludge Disposal Trickling Filters, Activated-Sludge Process and Contact Aerators After Inspection of 40 Plants in the United States and Canada

By Karl Imhoff
Chief Engineer, Ruhrverband, Essen, Germany

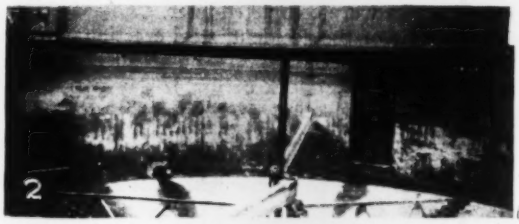
Everyone concerned with sewage treatment should be grateful to Dr. Imhoff for his masterful summary of the progress and status of that art in the United States and Canada presented below. Seldom is so much technical opinion, based on widespread observation of current practice and reinforced by long experience, presented with such clearness and condensation. The article pictures the outstanding features of American sewage-works practice today, with its various combinations of multi-stage treatment centering in tanks, trickling filters and accessories, on the one hand, and on the other the more nearly self-contained activated-sludge process which is coming rapidly to the front but gradually taking on some multi-stage features. Dr. Imhoff's statement that "no further technical improvement" in trickling filters "seems to be possible" may surprise some, but it is not so challenging as his "impression" that "the day of the trickling filters will be passed in the near future." The article is bound to have the attention of the specialist. It will repay reading by all engineers who wish to keep posted on progress in other fields than their own. —Editor.

THE United States has far more new and good sewage-treatment plants in operation and under construction than any other country. Their great technical success is due mainly to the co-operation of consulting engineers, state sanitary engineers and city officials. Such is my conclusion after inspecting more than 40 widely distributed American and Canadian sewage plants in April and May, 1929.

Independent fine *screens* now are not thought to be sufficient at the seacoast. Better results for the money are thought to be obtained from the use of settling tanks of relatively short detention period. But mechanical screens are more and more used for pretreatment in tank plants as opposed to German practice. With screenings there is a tendency to shred and then to digest them combined with the sewage sludge.

Difficulties with *oil and grease* are increasing in nearly all plants. Skimming tanks without aeration may be sufficient for mineral oil. Aeration seems to be necessary for removing the organic grease. Interesting experiments are being made at Los Angeles, Calif. It is advisable to build skimming tanks in two stages, the first stage for mineral oil without aeration, the second stage aerated for grease. If fine screens may be arranged ahead of the skimming tanks, there is the advantage of having no fecal matter in the grease.

In nearly all *preliminary settling tanks* presedimentation is combined with sludge digestion, either in two-story tanks or in one-story separate digestion tanks. Two-story tanks are by far predominant, even in new plants and designs. The newest list of U.S.A. plants (*Engineering Construction Markets*, May 10, 1929; McGraw-Hill Publishing Company, Inc., New York City) gives 1,027 Imhoff tank plants and 99 separate sludge digestion plants.



FIGS. 1 AND 2—COMBINED OIL-AND-GREASE AND DETRITUS REMOVAL TANK, AKRON, OHIO

Above—Skimmers in operation, with grease splotches at left. Below—Tank empty; skimmers exposed above and detritus scrapers below.

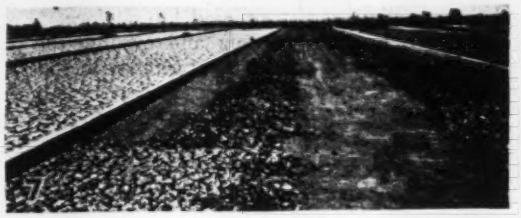
FIG. 3—FIDDIAN (ENGLISH) SCRAPER IN SETTLING BASIN OF NORTH TORONTO SEWAGE-WORKS

FIGS. 4 AND 5—TOP OF IMHOFF TANK, SAN BERNARDINO, CALIF.

Above—Gas catcher, with pressure water pipe at left; floating-scum outlet on other side. Below—Hand pumps and hose for measuring sludge level; in foreground, mechanical skimming device.

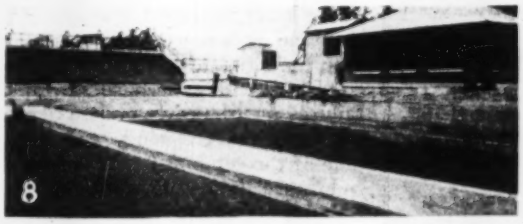
DRIED SLUDGE ON DRYING BEDS AT FOUR SEWAGE-WORKS

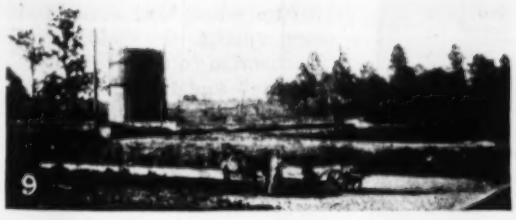
The first of the two Lodi views shows fresh activated-sludge with many wide cracks. The Calumet view shows relatively few and narrow cracks.



DRYING BEDS FOR ACTIVATED SLUDGE AT LODI, CALIF.

Above—Fresh activated sludge dried on sand in two weeks, with shrinkage from 10 in. to ½ in. depth. Total area of cracks exceeds that of the dried sludge. Below—Dried sludge being removed.





TWO EXAMPLES OF MIXTURE OF ACTIVATED AND PRELIMINARY TANK SLUDGE

Above—Pomona, Calif., sludge partly digested. Below—Sugar Creek works, Charlotte, N. C. Sludge, almost fully digested, being loaded into manure spreader. Gasholder for gas from sludge-digestion tank in distance.

WELL-DIGESTED SLUDGE AT CALUMET PLANT, SANITARY DISTRICT OF CHICAGO

With *one-story settling tanks* usually scrapers are arranged for sludge removing—especially the Dorr scrapers. In general the scrapers are working to satisfaction for preliminary sludge. I was told of one case where heavy sphærofilus growth collecting on the scrapers would stop rotation. But the weak point of the system is the sludge digestion tank. The writer did not see any really digested sludge from separate tanks on his trip. The best way to improve these conditions seems to be the heating of the digestion tanks, which is beginning to be used in new plants. It could be very easily added also in old plants.

In *two-story tanks* frequently outlets for scum are provided as at San Bernardino, Calif. To avoid scum and foaming in any digestion tank, Prof. A. M. Buswell pumps once a day the water from the digestion tank upon the scum for stirring and dilution (*Industrial and Engineering Chemistry*, April, 1929). This is done without removing the gas hood. The advantages in comparison with the well-known flushing with clear water are: (1) It is less expensive; (2) there is no change in the content of the sludge chamber; no sludge can be pressed in the effluent; (3) the water of the digesting tank contains the bacteria which help to digest the grease in the scum. For the future it will be advisable to install the pipe connection for flushing water under each gas hood so that the water from the digesting tank may be pumped by a portable pump as often as necessary. The arrangement will be useful in separate as well as in two-story digesting tanks.

Sludge gases are now utilized in some plants for power supply or for heating.

Sludge-drying beds are very carefully constructed and operated in most of the large plants.

Sludge lagoons are considered to be a nuisance if operated with fresh sludge; but there are plants giving excellent results where lagoons are filled with digested sludge in order to save the operation costs of sludge-drying beds.

Trickling filters are built in many large new plants. The construction is nearly uniform, and no further technical improvement seems to be possible. It is the impression of the writer that the day of trickling filters will be passed in the near future.

The *activated-sludge process* of sewage treatment is coming up rapidly. The Milwaukee plant, including the fertilizer factory, is working excellently, also from the economical standpoint. But there seems not much tendency among the American engineers to go into the fertilizer business. The Milwaukee conditions are said to be exceptionally favorable. Pasadena and Houston, the only two similar plants, are less economical. (The Houston fertilizer plant burned down some months ago and lagoons were again put into operation.)

In Lodi, Calif., the excess activated sludge is dried on sand beds. In Charlotte, N. C. (Irving plant), the sludge is first dried in a vacuum filter and then put on land. In New York (Wards Island design), the sludge will be barged to the ocean. Ordinarily the excess activated sludge is treated in digesting tanks, combined with the preliminary sludge. Some plants of this kind are working to satisfaction.

The power consumption in activated-sludge plants is still high. It should be possible to reduce the power by improving the system in details.

Submerged *contact aerators* are running in three or four experimental plants only.

Why Joints in Concrete Pavements?

A Discussion of the Stresses Set Up in Concrete Pavement Slabs by Temperature, With a Statement of Joint Construction Designed to Prevent Cracking and Spalling

By Clifford Older
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JOINTS in rigid pavements are presumed to serve two general purposes: (1) to prevent so-called blow-ups and (2) to control cracks. A third duty might well be added, that of preventing spalling due to unrelieved compressive stress. This is often confused with scaling or so-called raveling.

Direct Average Temperature Stresses

Perhaps the assumption that concrete will expand or contract about 0.000006 times its length in any direction per degree change of temperature is substantially correct. It is obvious, then, that if a cylinder of concrete, for example, be prevented in any way from lengthening when its temperature rises 1 deg., it would in effect be compressed 0.000006 times its length. If the modulus of elasticity of the concrete be taken as 3,000,000 and it is prevented from expanding or contracting, a unit stress equal to 3,000,000 × 0.000006, or 18 lb. per sq.in., would be set up in the concrete per degree change of temperature.

If for convenience we assume that concrete weighs 144 lb. per cubic foot, it may readily be shown that while a pavement slab is expanding or contracting, subgrade friction will set up a unit stress in the concrete at any point equal to the coefficient of friction times the distance in feet to the nearest free pavement edge. Goldbeck has shown that the coefficient of subgrade friction may readily attain values of 1.5 to 2.0. Assuming that it is 2.0, subgrade friction during temperature changes will cause, halfway between slab ends or edges, a stress in pounds per square inch equal to the length or width of the slab in feet, provided the temperature change is great enough.

This simple rule for finding friction stress in a slab is probably as accurate as any other for average conditions.

If 1 deg. change of temperature is capable of producing an expansion force of 18 lb. per sq.in., it follows that only 1/18 deg. is necessary to produce a stress in tension or compression sufficient to overcome the subgrade friction of 1 ft. of length or width of pavement. Thus a daily average temperature change of 10 deg. (often exceeded) would be sufficient to produce a tension of compression of 180 lb. per sq.in. in an unbroken slab 180 ft. long and a winter to summer change of 120 deg. a stress of 2,160 lb. per sq.in. in a slab 2,160 ft. long.

Only what hereafter will be called the resultant stress due to change in the average temperature may be determined approximately in the above manner. The maximum temperature stress over a part of the cross-section may be very much greater. This is true, because changes in the average temperature are brought about by the warming or cooling of the exposed top surface. For a few minutes only each morning and evening the temperature of the top and bottom surfaces may be the same. At times during the remainder of each day there may be a temperature difference of from 10 to 20 deg. (see "Highway Research in Illinois," *Transactions*, Am.Soc.C.E., Vol. 87, p. 1194). It is hardly necessary to say that this condition often produces a stress near the top or bottom surface that must be added to the resultant heretofore mentioned.

Issue is taken in this article with a number of practices believed to be effective in reducing joint and crack troubles in concrete pavement. The argument is based directly on a quantitative interpretation of temperature and live-load stress effects, and is a refreshing change from the crack enumeration process which in late years has substituted the averaging of counts for technical reasoning. That the article will find agreement by all is not to be expected, but something more than crack censuses will be needed if its reasoning is to be demolished. In any event the discussion, coming from an engineer whose practical experience, extended experimental work and constructive thinking are recognized, deserves to be read carefully.
—Editor.

Combined Bending and Temperature Stresses

When temperature stresses are added to the bending stresses due to traffic loads, the total may easily exceed the endurance fatigue limit or even the ultimate strength of the concrete. Cracking because of fatigue failures may be early or late depending upon the frequency and magnitude of the combined stress above the endurance limit. This may be illustrated by assuming that the thickness of a certain pavement is proportioned so that the wheel load alone produces a stress equal to the endurance limit of the concrete (one-half the modulus of rupture) and that this endurance limit is 300 lb. per sq.in. Then at mid-length of the slab, subgrade friction alone during cooling will add about 3⅓ per cent to the live load stress for every 10 ft. of distance between joints or cracks.

Thus the frequent passage of maximum traffic loads while the temperature is falling may be expected to result in transverse cracks because of fatigue unless due allowance in thickness is made for slab lengths.

Allowable Stress for Crack Control

In the light of preceding statements it is submitted that if we expect to control transverse cracks we must drop the allowable live load working stress below the endurance limit at least 1 lb. per sq.in. for each foot of distance between joints. Even this will provide for the average or resultant temperature stress only and leave no factor of safety with respect to the endurance limit or allowance for uneven distribution or uneven subgrade support.

Applying this rule to allowable stress will be found to add about ¼ in. to the thickness for each 10 ft. of slab length. The economical joint spacing will, of course,

be dependent upon the relative cost of joints and added thickness and area of tie steel. Ordinarily it will be somewhere between 25 and 30 ft.

It is believed that ultimately we shall use one-third rather than one-half of the modulus of rupture for working stress and also apply a reduction factor for slab length. The added factor of safety would eliminate corner breakage and greatly reduce if not eliminate cracking because of uneven subgrade bearing or settlement. Experience in the control of transverse cracks by a certain joint spacing is of no significance unless the actual weight and number of traffic units are known.

Direct Average Compressive Stresses

So far we have considered tension only; compression is perhaps of equal importance. If we assume that the maximum range of pavement temperature between winter and summer is 120 deg. and assume that at lowest temperature there are no open joints or cracks in a pavement of indefinite length, the resultant compressive stress at highest temperature would be about 2,160 lb. per sq.in. As pavement concrete may test over this figure, it would seem at first sight that this should not be a prolific cause of crushing failure (blow-ups) except perhaps because of fatigue after a period of years. However, we know by experience that if expansion joints are not provided, such failures do occur with more or less frequency in new as well as in old pavements. The explanation is simple. Melting snow and spring rains may increase the moisture content and thereby cause a certain unknown amount of expansion; it is possible that it may be as great as that caused by the maximum range of temperature. Add to this the temperature expansion caused by a warm spring day and even the average compressive stress over the cross-section may exceed the compressive strength of the concrete and blow-ups are all but certain.

The compressive stress is relieved to the extent that cracks and joints may be open in the winter, but this in turn is counteracted by accumulations of dirt that prevent them from closing in hot weather. Dirt confined between parallel surfaces may become as unyielding as the concrete itself. There can be but little doubt that dirt accumulations in joints and cracks may readily account for the blow-ups that frequently occur in pavements that have been free from such trouble for a number of years. This may also be largely responsible for much of the spalling so prevalent at joints and cracks.

The whole matter of volume change because of moisture variation in a pavement slab is likely to be so complicated by climatic conditions, subgrade capillarity, porosity of concrete, etc., that it can never be evaluated except in the most general way. At present it would seem that the best that can be done is to make a generous allowance for temperature variation and hope that it will be enough to provide for moisture effects also.

Aside from the unequal compressive stress in the body of the slab at the top and bottom due to unequal relative temperature and moisture, excessive compression may and does occur at either top or bottom edges adjacent to cracks or joints for another reason. The downward warping of the pavement margins when warmed by the sun brings the top edges adjacent to a crack or joint in contact before the rest of the pavement and causes the resultant expansion thrust to be applied at or near the top surface. This may also be the result of uneven subgrade settlement.

The unit expansion stress that might otherwise be expected may therefore easily be doubled, trebled or even multiplied many times at or near the top or bottom surface at a joint or crack. Spalling at joints and cracks is the inevitable result unless expansion pressure is relieved at frequent intervals by introducing expansion joints. This is often mistaken for scaling or so-called raveling.

Spacing Expansion Joints

The correct spacing of expansion joints to avoid all expansion trouble may not easily be determined by any theoretical consideration. A net effective expansion space aggregating about 1 in. per 100 ft. corresponds approximately to the expansion expected from the probable maximum winter to summer temperature range and should be considered the minimum. While material expansion due to increased moisture content may occur more or less simultaneously with maximum temperature, experience seems to indicate that an aggregate of about 1 in. of effective expansion space per 100 ft. is sufficient to avoid blow-ups at least.

If such an aggregate effective expansion space is not provided or is concentrated at wide intervals or is filled with a material that does not yield without material resistance, spalling that may reach damaging proportions may easily result. Consider a crack or construction joint halfway between expansion joints of adequate width. The average unit pressure at this point during expansion would equal approximately 1 lb. per foot of distance between expansion joints because of subgrade friction, and to this must be added the unit resistance of the expansion joint to closing. The resultant per inch of width would of course equal the unit pressure times the slab thickness. The maximum stress at the top surface would depend upon the distance the resultant is applied above the neutral axis. If we assume that the resultant is applied $\frac{3}{4}$ in. below the top surface of a 7-in. pavement when the pavement is warped by the sun, then the unit compressive stress at the top surface would be about 620 lb. per each 100 ft. between expansion joints plus an equal amount per 100 lb. of unit resistance in the expansion joint material. The total would figure about 3,700 lb. per sq.in. for expansion joints spaced 100 ft. apart, that offer 500 lb. per sq.in. resistance under road conditions. This illustrates the prime need of caution in the design and spacing of expansion joints.

With low-resistance expansion joints it would seem reasonable to believe that spalling as well as blow-ups might be largely if not completely eliminated by spacing such joints at intervals of approximately 100 ft., providing intermediate joints, which in all cases should be edged, are introduced at close intervals to eliminate cracks. Cracks cannot be edged, and if all spalling is to be completely elim-

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inated, cracks must therefore be eliminated also and all joint edges rounded with an edging tool in order to prevent excessive pressures at the extreme top surface. In any case effective means to prevent the entry of a soil filler is essential if future trouble is to be avoided.

Type of Contraction Joint

It would seem worth while to consider the effect of so-called dummy joints. If such a joint is opened for half the thickness of the pavement, the average unit compressive stresses would be just double that which would otherwise occur. If through intent or carelessness the cut is made deeper, the resultant stress will be proportionately greater. If used at all, either the cut should be made entirely through the slab, or else rigid precautions should be adopted to insure that it be made only to the absolute minimum depth required to control the location of the crack.

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The capacity of such construction to relieve excessive load edge stresses by support from the adjacent pavement slab because of the interlocking roughness of the fractured area is open to serious question.

In addition to a possible weakening of the slab by the crushing or spalling of the hidden lower portion, the capacity of such construction to relieve excessive live load edge stresses, especially in cold weather, by support from the adjacent pavement slab because of the interlocking roughness of the fractured area is open to serious question. It would seem unwise to depend upon such accidental doweling means alone to prevent excessive edge stresses throughout the service life of the pavement. It would be extremely hazardous for longitudinal joints where there is a daily hinge action due to warping and a far greater angular seasonal movement with a constant tendency for the joint to spread in spite of the use of deformed tie bars.

Observations made at several places in Illinois indicate that during the winter and spring the elevation at the center joint of an 18-ft. pavement as compared with that at the edges frequently varies as much as 1½ in. and occasionally 2 in. or more at different periods during the frost season. This of necessity greatly reduces the roughness interlock and perhaps ultimately causes its complete breakdown.

If doweling action cannot permanently be counted upon at a joint, whether it be transverse or longitudinal, it follows that the slab edges must be thickened in accordance with the accepted ten-sevenths ratio if excessive live-load stresses are to be avoided. A positive built-in means for efficiently doweling all joints and possible cracks would seem wise. The cost is trifling compared with the risk of destruction involved in counting upon rough fractures alone in the thin mid-portion of a slab.

Thickened edges at transverse joints add more or less anchorage to the unavoidable friction drag and thereby materially increase not only the probability of intermediate cracking but also that of broken interlock at such cracks because of excessive widening. Also, effective doweling is normally cheaper than edge thickening.

When steel tires prevailed it was found necessary to spread crack filler over the pavement surfaces adjacent to cracks to prevent wheel pressure concentrations sufficient to cause vertical spalling. With rubber tires the characteristic damage caused by steel tires to pavement edges has all but disappeared. Practically all of the localized damage we now find at joints and cracks, with the exception of corner breaks, may easily be traced to horizontal rather than to vertical pressure. If, therefore, we reduce horizontal pressure to allowable proportions by proper expansion joints and eliminate cracks by substituting joints with rounded edges, crack filler may and should be strictly confined to that amount necessary to exclude dirt from the joint. No material need be spread over the adjacent surface and renewal need not be frequent.

If the conditions discussed in the foregoing are substantially true, the following deductions may be made:

1. The practical control of cracks is feasible if we are willing to take the proper precautions in design.

2. Reasonably certain results may be expected if the allowable live-load stress is conservative and reduced as distance between joints increases. The uncertainty lies chiefly in the subgrade factor. On account of possible subgrade movements, absolute freedom from all cracking may never be economically practicable, although it is believed that normally the trouble from this source will be small if the principles of design herein outlined be observed.

3. In order to insure the effective doweling of any such intermediate cracks as may appear, a welded wire mesh or welded bar mat with area of steel proportioned to slab dimensions should be embedded in the concrete to prevent the widening of the crack.

4. It is probable that under average cost conditions cracks may be most economically controlled by spacing joints not more than 15 to 30 ft. apart. Only a part of the joints need be expansion joints.

5. Blow-ups may be avoided with reasonable certainty by introducing expansion joints aggregating about 1 in. of effective expansion space per 100 ft.

6. The danger of spalling increases in proportion to the distance between expansion joints and their resistance to closing. This distance may approach 100 ft. with reasonable safety provided the resistance of the expansion joint itself to closing is very small; otherwise a much closer spacing would seem to be imperative.

7. All joints should be edged to aid in reducing spalling.

8. Soil should be kept out of cracks and joints in so far as may be feasible.

9. Danger of excessive live-load edge stresses calls for efficient built-in means for doweling all joints.

10. Danger of weakening by crushing or spalling calls for the avoidance of any form of transverse joint that may cause an unnecessary concentration of expansion pressure over a limited portion of the cross-section.

11. It does not seem unreasonable to expect, with a balanced arrangement and spacing of properly constructed doweled joints, a corresponding allowance for live-load stress and a logically proportioned reinforcing mesh, that the useful pavement life may be materially extended, costly disfiguring tar kettle maintenance greatly reduced or even practically eliminated and the whole accomplished with ultimate economy.

There are some indications that the public is willing to stand a little more first cost if its investment in pavements could be made safer. It is to be hoped that engineers will be ready to add the factor of investment safely.

FIG. 1—KIYOSU BRIDGE OVER SUMIDA RIVER, TOKYO, JAPAN

Plate Chains a Feature of Tokyo Suspension Bridge

Japanese Engineers Design Chains With Links of Rolled-Steel Plates—Bridge of Self-Anchored Type—Suspenders Carry Box Girders Supporting Highway Deck

A CHAIN suspension bridge in which the chain links are flat plates instead of eyebars is a notable structure and a novelty in bridge design which has been completed recently to replace an old highway bridge across the Sumida River in Tokyo, Japan. The structure, known as the Kiyosu suspension bridge, is of the self-anchored type, has a main span of 300 ft. and side spans of 150 ft., the latter suspended from the backstays. It is 85 ft. wide over all, with chains spaced 60 ft. c. to c. Between the chains is a 54½-ft. roadway and outside are two walks. Views of this bridge are given in Figs. 1 and 2.

Wire cables were considered, but were rejected by the designer, according to information furnished by Mikishi Abe, consulting engineer, Tokyo, who gives the following reasons: (1) difficulties in erection; (2) uncertainty as to the elastic properties, (3) very little material that is reliable for such cables is manufactured in Japan and numerous tests on available material gave unsatisfactory results. Plates and pins for the chains are of Ducol steel, made in Japan, containing 1.5 per cent manganese. Its minimum yield point is 56,000 lb. per sq.in.; minimum ultimate strength, 89,600 lb.; minimum elongation, 18 per cent (length not stated).

There are twenty 15-ft. panels in the main span and ten in each side span. The sag is 42 ft. in the main span. At the towers each chain (Fig. 3) is composed of six plates 38x1 in. and 18 ft. 9½ in. c. to c. of pinholes.

FIG. 2—THE KIYOSU BRIDGE AT TOKYO
Note the plate-link chains.

In the two end panels of the backstays each chain is composed of four eyebars 20x2¼ in. In the third backstay panel and the middle panel of the main span there are five plates 36x1¼ in. All chain pins are 12 in. in diameter, with the exception that the diameter of the anchor pins in the box girders of the side spans is 18 in. and that of the pins in the next two panel points

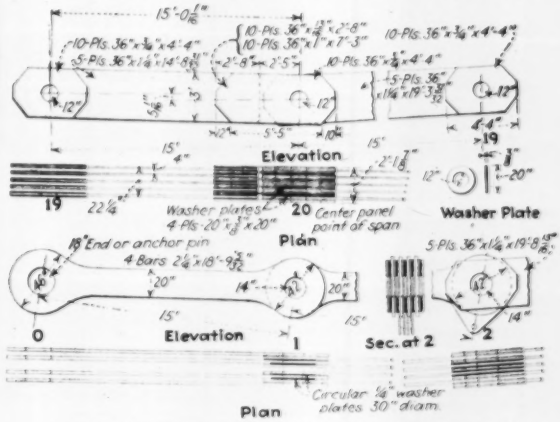


FIG. 3—SUSPENSION CHAINS COMPOSED OF PLATE LINKS
Eyebars in two end panels of backstays.

is 14 in. The diameter of the eyebar heads is 46 in. for the anchor pin and 42 in. for the 14-in. pins. Towers of structural steel carry the saddles (Fig. 4), each of which has two pins for attachment of the main chain and backstay chain respectively. Packing plates are fitted between the ends of the plates and circular washers or packing plates between the heads of eyebars.

Short suspenders (Fig. 5) are pairs of eyebars on the ends of the chain pin and a smaller pin carried by plates built into the box girders, these pin plates extending above the top chords. Longer suspenders, also shown in Fig. 5, are composed of 4½-in. rods, with the inner ends upset to 5 in. and threaded for turnbuckles, while the outer ends are forged as forks or clevises. At the lower end, the clevis straddles a connection plate or pin plate on the top chord of the girder. At the upper end the clevis engages the cast-steel spreader of a Y-shaped yoke composed of a pair of bent eyebars fitted

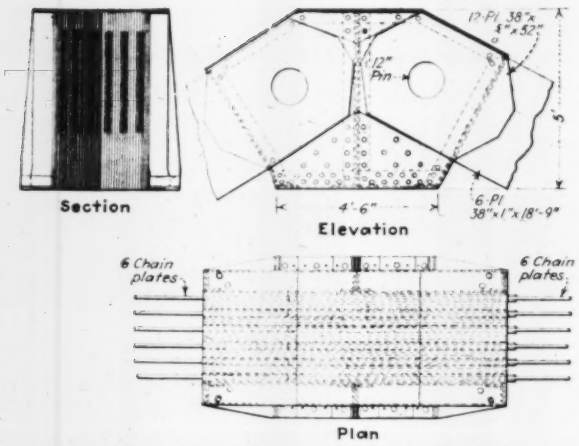


FIG. 4—SADDLE FOR SUSPENSION CHAINS

to the chain pin and with the spreader between their lower ends. A different arrangement is used for the suspender at the middle point of each main chain. Here also, as shown in Fig. 5, the bent eyebars of the yoke, 8½ ft. long, extend below the spreader and engage a pin at mid-depth of the box girder. In addition a rectangular frame of heavy steel angles encircles the chain at this point and is riveted to the top chord of the girder.

For the suspended deck, each chain carries a box girder 8½ ft. deep, to the webs of which are framed the plate-girder floorbeams of roadway and sidewalks. Pipes and conduits are carried through the roadway beams. Upon the floorbeams and stringers are buckle plates with concrete filling, and in the middle of the roadway is a double-track electric railway with T-girder rails bolted to shallow trough-shaped steel ties. The girders are cut at the center of the main span and just forward of each tower, with a pin bearing at mid-depth of girder at each point (Fig. 6). Heavy construction

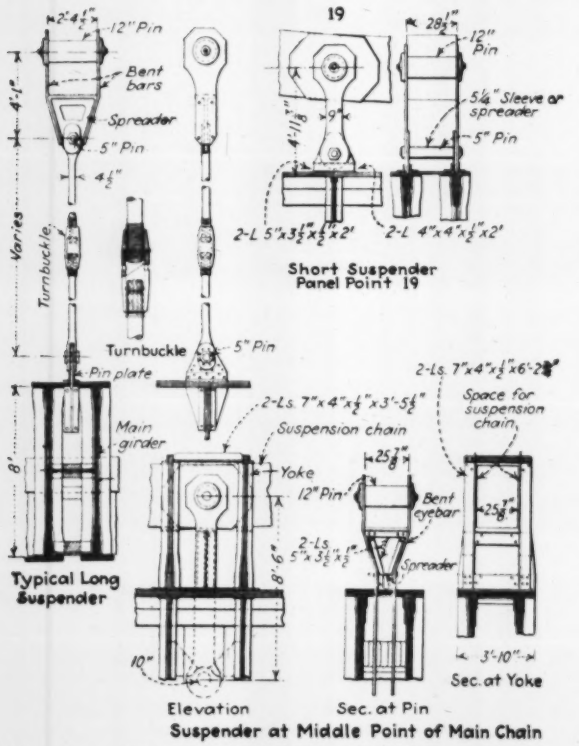


FIG. 5—TYPICAL SUSPENDERS

is used in the box girders, and they are stiffened by cross-struts and diaphragms between the webs. They have pin bearings over the piers and on the abutments.

At the center of the main span there is a clearance of 22 ft. above low-water level. Pneumatic caissons were used to carry the foundations of the masonry piers down to solid ground. Upon these piers are the shoes for the pin bearings of the girders and the posts of the towers. These towers are 61 ft. high from shoe pin to center of saddle, or 65 ft. 9 in. from top of masonry.

This notable suspension bridge was designed by Prof. Yutaka Tanaka, of the Tokyo Imperial University, as chief engineer and Seichi Suzuki assistant engineer.

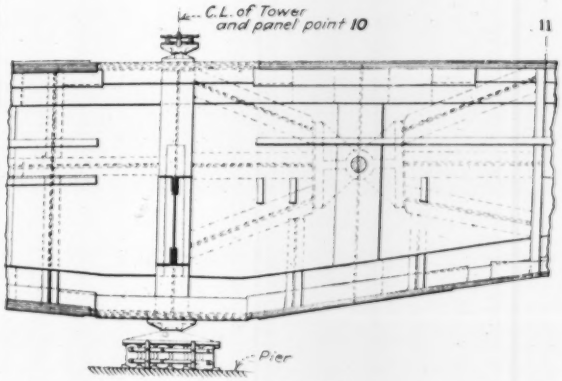


FIG. 6—PIN BEARINGS IN BOX GIRDERS

While the pneumatic foundation work was done by local contractors, it was under the direction of engineers from the Foundation Company, New York. Design, steel manufacture and erection of the superstructure was in the hands of Japanese engineers, contractors and steel manufacturers.

China Building Roads, but Not for Public Use

Plans for roadbuilding in China are beginning to materialize in various parts of the country though the initiative of provincial authorities, according to a report received by the U. S. Department of Commerce. An elaborate system of eleven national highways has been drawn up, but due to the shortage of government funds, active road construction must be done by the provincial authorities. The right to operate motor cars over the newly constructed road is chiefly reserved to government officials or private bus interests that have either built the roads or purchased operating franchises. Private citizens have little opportunity or, as yet, desire to utilize existing roads outside of those at the foreign treaty ports.

Highway Construction in Canada

Highway construction in Canada is keeping pace with the increasing use of the automobile and the rapidly advancing tourist traffic. During the past three years, according to a recent government statement, 35 per cent has been added to the mileage of surfaced highways. On March 31, 1915, the provinces reported a total of 47,411 miles of surfaced roads. By the end of 1928 this had been increased to 64,121 miles. In 1928 alone 8,610 miles of highway was constructed, of which 2,454 miles was earth and the remainder surfaced. The total expenditure on new roads was $38,912,029, while $18,963,381 was spent in maintenance.

Lighter Structures

Two Articles on an Important Development in the Aluminum Industry

Second Article: New Massena Mill Will Roll Plates and Shapes of Strong Aluminum Alloy

By Robert L. Streeter
Vice-President in Charge of Fabrication, United States Aluminum Company, Pittsburgh

IN THE preceding article the nature of the strong alloys of aluminum and how industry has made use of these alloys was briefly sketched. A remarkable industrial development that is just approaching completion, after studies of new technological problems during the last few years, now opens the way for a large extension of the range of structural use of these materials. This development is briefly summarized in the announcement that the Aluminum Company of America is adding two important units to its Massena, (N. Y.) plant: a large blooming mill to handle ingots comparable in size with those of steel open-hearth practice, and a structural mill to produce shapes to a maximum depth of 14 in. and a length of 85 ft. At its Alcoa (Tenn.) plant plans have been laid down for a sheet and plate mill of large capacity with respect to dimensions and tonnage of product.

The two new mills will put into the hands of the engineer and builder the material for structural members of strong aluminum alloys of a size and general utility heretofore unobtainable. Hitherto these alloys have been available only in relatively small sizes of rolled plates and extruded structural shapes limited to 4x4-in. angles as a maximum. These have been adequate up to the present, but are now being outgrown in range. The strong alloys are entering fields of construction where their usefulness would soon be seriously handicapped were it not for the larger shapes which the new Massena mill will produce.

The sizes and shapes which can be rolled or extruded depend largely upon the requirements of the trade. When there is a sufficient demand for larger sizes and shapes, undoubtedly the mills will be equipped to meet these demands. At the present time the maximum widths for strong alloy plate are as follows: 0 to 18 gage, 60 in.; 19 to 20 gage, 48 in.; 21 to 24 gage, 42 in.; 25 to 27 gage, 36 in.; 28 to 30 gage, 28 in. The maximum length depends upon the gage of the material and the weight of the rolling ingot.

Obviously, the first difficulty encountered in the rolling of large structural shapes was in obtaining ingots of satisfactory metallurgical characteristics. Although the temperature employed in rolling aluminum is much lower than that in rolling steel, a more rigid temperature control is essential. For this reason considerable attention had to be given to the development of proper pyrometric control. It was also found that certain modifications had to be made in the roll pass design. Means had to be worked out as well for heat treating lengths up to 85 ft. without excessive distortion. Even after the best methods had been developed there was some distortion, since aluminum alloys are heat treated at a relatively high temperature. This meant that a satisfactory means for straightening had to be devised.

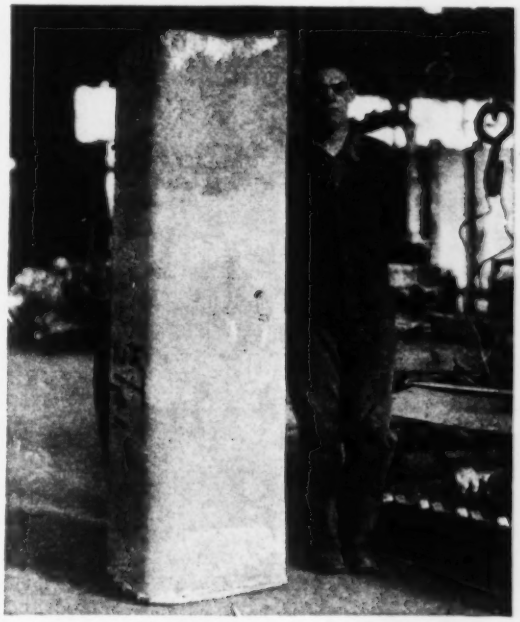


FIG. 2—ALUMINUM INGOT FROM WHICH BLOOMS AND BILLETS WILL BE ROLLED AT MASSENA

The shapes to be rolled will not differ a great deal in form from the structural shapes developed in the steel

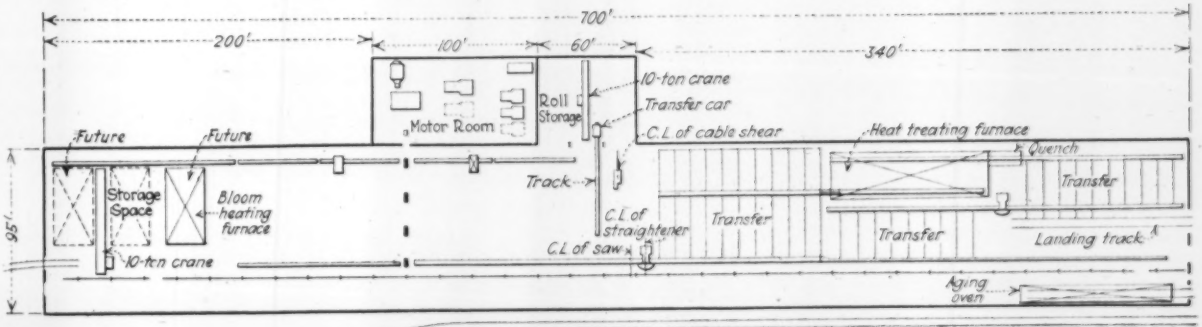


FIG. 1—GENERAL LAYOUT OF STRUCTURAL MILL AT MASSENA, N. Y.
Aluminum shapes as large as 141 in. deep and 85 ft. long will be fabricated.

industry. The general utility value of these shapes has been too firmly established in construction work to call for any discussion of that phase of the problem here. Even the layman speaks of I-beams, angles, channels, etc., with an air of familiarity. The detail dimensions of the cross-sections of various steel shapes have been developed over a period of years and represent a compromise between what the manufacturer could roll, what the builder could use and what theoretical considerations and experiments had shown to be the most economical distribution of the steel in the different sections. In selecting the form and dimensions of cross-section for shapes of strong aluminum alloys, it could be assumed that the dimensions of sections standardized in steel practice were approximately the ones best suited to high-strength aluminum alloys.

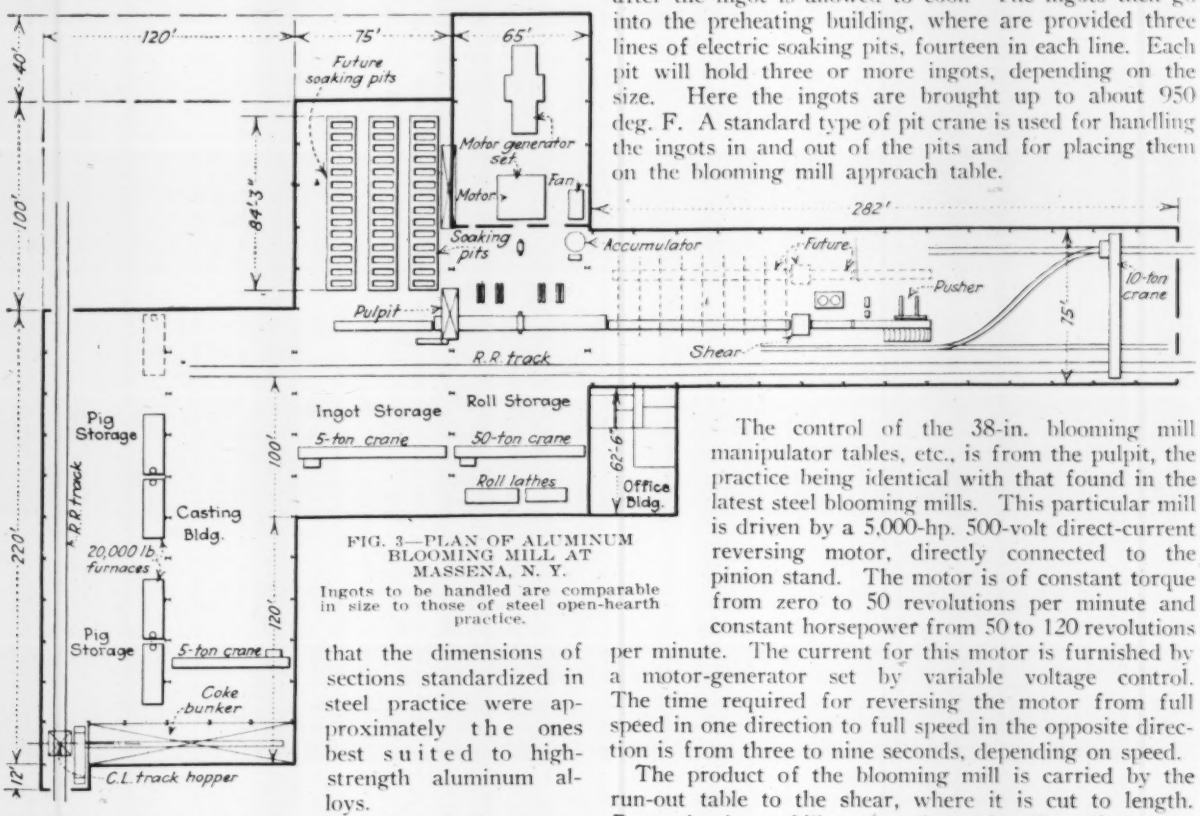


FIG. 3—PLAN OF ALUMINUM BLOOMING MILL AT MASSENA, N. Y.

Ingots to be handled are comparable in size to those of steel open-hearth practice.

It is interesting to note that the rolling of these strong alloys requires an appreciable increase in power as compared with steel. This one point aside, it is clearly demonstrated by what has been accomplished so far that such shapes in aluminum are satisfactory generally, both as regards production and in their application to engineering construction. Certain differences in the mechanical properties of steel and aluminum make it appear that minor revision or modification of proportions from those adapted for steel will be desirable in order to produce the most efficient sections with aluminum.

New Massena Mill

A plan of the new blooming mill built at Massena is shown in Fig. 3. This mill, which has been constructed by the Mesta Machine Company, of Pittsburgh, follows very closely the practice of the latest blooming mills used for the rolling of steel.

In this case the ingots used for rolling blooms and billets will be about 20x22x72 in., weighing 3,000 lb. For rolling sheet slabs, ingots up to 34 in. maximum width may be utilized, as it will be possible to open the rolls 36 in. This mill will furnish blooms for the structural mill already mentioned, forging billets which will be used for such things as aircraft propeller blades, locomotive connecting rods and other large forgings; billets for the existing rod and wire mills at Massena, and slabs for the present sheet and plate mills now operated by Aluminum Company of America.

The blooming mill group of buildings includes the melting and casting building, the preheating building, blooming mill proper and run-out building. The remelting and alloying are done in open-hearth furnaces using coke as a fuel. The ingots are cast in this building and the necessary trimming and scalping is performed after the ingot is allowed to cool. The ingots then go into the preheating building, where are provided three lines of electric soaking pits, fourteen in each line. Each pit will hold three or more ingots, depending on the size. Here the ingots are brought up to about 950 deg. F. A standard type of pit crane is used for handling the ingots in and out of the pits and for placing them on the blooming mill approach table.

The control of the 38-in. blooming mill manipulator tables, etc., is from the pulpit, the practice being identical with that found in the latest steel blooming mills. This particular mill is driven by a 5,000-hp. 500-volt direct-current reversing motor, directly connected to the pinion stand. The motor is of constant torque from zero to 50 revolutions per minute and constant horsepower from 50 to 120 revolutions per minute. The current for this motor is furnished by a motor-generator set by variable voltage control. The time required for reversing the motor from full speed in one direction to full speed in the opposite direction is from three to nine seconds, depending on speed.

The product of the blooming mill is carried by the run-out table to the shear, where it is cut to length. Pure aluminum billets for the rod mills will be cut into lengths of about 48 in., and other billets and blooms into various lengths required.

Since this mill will necessarily be used for a wide range of production, provision has been made for operating it in a little different way than that in which steel blooming mills are operated. For instance, it will be necessary to shear up certain sizes of slabs, reheat them and reroll them in order to get slabs of the proper dimensions to supply the present sheet and plate mills. This really makes the mill a combination blooming and slabbing mill.

Naturally, roll changes will be frequent. Particular attention has been paid to the roll-changing devices in order to insure minimum time loss for such operations. It is expected that the capacity of this mill in aluminum will be 500 tons per day, which corresponds to the 1,500-ton steel mill.

The general layout of the structural mill is shown in Fig. 1. The main building is 75x700 ft. with 20-ft. lean-to the entire length; provision has been made for future extension of 500 ft. On the opposite side from

the lean-to is a building 50x160 ft., housing the mill drive, motor-generator sets and other auxiliary equipment.

The lean-to is utilized for roll storage, aging chambers, heating furnaces, etc. The blooms from the blooming mill are brought in at the left on a narrow-gage track and preheated in an oil-fired furnace, the discharge of which is direct on to the roll table carrying the blooms to the tilting table, the roughing mill being on the side adjacent to the motor building.

The mill consists of three three-high stand and one two-high stand 28-in. rolls, which will be served for the present by a traveling and tilting table on either side of the mill. These tables are supplemented by traveling trailer tables. Provision is made, however, for additional traveling, tilting and trailer tables to be installed in the future as required for increased production.

As installed, the mill is driven by one 2,000-hp. variable-speed direct-current motor, equipped with variable voltage control. The current is furnished by a special motor-generator set. Provision is made for installing an additional motor of the same or less horsepower as required for additional capacity. With the added equipment mentioned, the mill will have a capacity of 250 tons of aluminum shapes per day.

Up to this point the operations are identical with those used in rolling steel shapes, but in the case of aluminum alloys it is necessary at this point to depart from the usual steel practice by inserting a heat-treating operation. All of the alloys that will be rolled will require heat treating and some of them will also require aging. As the shape leaves the finishing mill it will be given a rough straightening if necessary in a gag straightener, and then be carried on a transfer table to the roller table, which moves it endwise into the heat-treating furnace. In the furnace the shapes will be carried crosswise to the rollers, which will discharge them endwise. This arrangement allows the shapes to stay in the furnace long enough to be brought up to the heat-treating temperature. As the shape is discharged it moves through a water quenching spray just outside the furnace. At this point the alloys that do not require aging are completed except for final straightening, which is done in a gag straightener located at the end of the furnace runout table. Those alloys requiring aging will be taken by the crane to the steam aging-chambers and the final straightening of the shape will be accomplished after this operation.

Mill Crane Built of Aluminum Alloy

One of the early applications of strong aluminum alloy as a structural material was made in the 10-ton bridge crane in the rolling mill. Its span is 72 ft. 2 in. and its load capacity 10 tons. The reduction in weight resulting from the use of aluminum proved to be about 50 per cent. Since the 10-ton standard steel crane in the blooming mill runout building is an exact duplicate of this aluminum alloy crane, a very good opportunity will be presented for making a direct comparison between steel and aluminum cranes. Aside from any saving in operating expenses resulting from the lower power requirements of the aluminum crane, it was found possible to effect a substantial saving in the weight of the steel supporting columns and the crane girders. Such satisfactory results have been obtained with the crane in the rolling mill that six additional cranes are being made for use in some of the other plants of the company. One of these is noteworthy in that it will have a capacity of 50 tons and a span of 81 ft.

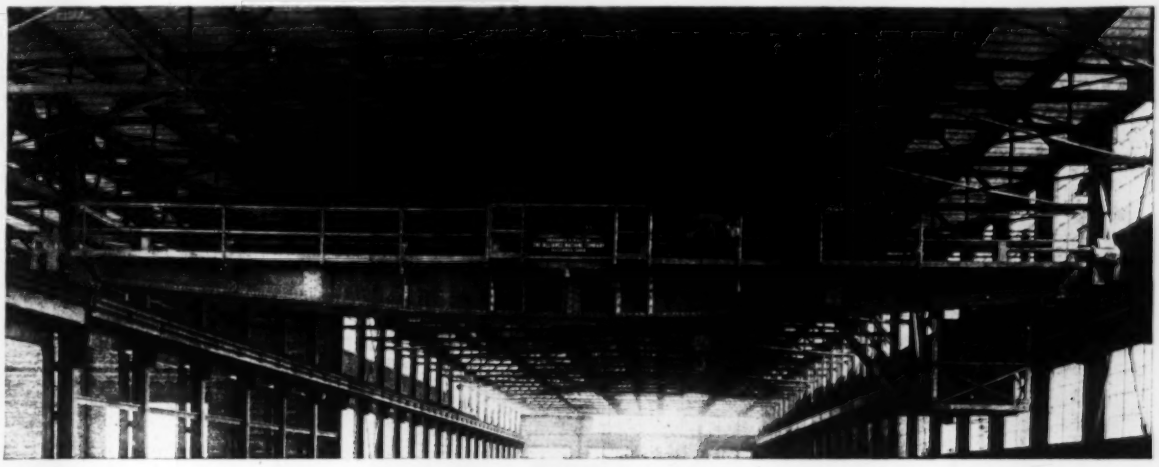


FIG. 4—BRIDGE CRANE OF STRONG ALLOY
An example of how aluminum is entering into the field of steel.

Aluminum structural shapes up to 14 in. in section and 85 ft. in length, and plate in the larger sizes, will supply many of the requirements of railway car, bus and truck body builders, and will provide suitable materials for such structures as traveling shop cranes, locomotive cranes, bascule bridges and the like. In some of these fields aluminum has been used to such an extent and for a sufficient length of time to prove its worth conclusively, while in some of the other fields its use is still experimental.

The structural and blooming mills will be finished well before the end of the year and the plate mill is planned to follow soon thereafter. The completion of these mills should give marked impetus to the crusade for the reduction of unnecessary and expensive mass movement. Wherever loads are hauled for revenue the strong alloys of aluminum seem destined to play a prominent part in reducing tare weights, the movement of which costs proportionately as much as does the transportation of the pay load.

Grand Trunk Relocates Its Line Through South Bend, Ind.

New Elevated Line Eliminates Street and Track Crossings—Six-Span River Bridge—Erection Methods

BY A combination of relocation and track elevation through the city of South Bend, Ind., the Grand Trunk Western Railway has eliminated all its fifteen street crossings at grade as well as a grade crossing of the tracks of the New York Central Lines, and has obtained access to a new union station. A somewhat spectacular feature in the construction of the new line was the erection of a six-span plate-girder bridge across the St. Joseph River, shown in Figs. 1 and 2.

South Bend's rapid development as an industrial center made the many existing grade crossings dangerous and inconvenient. The double-track main line of the New York Central traverses the city diagonally from northwest to southeast. The old single track of the Grand Trunk Western Railway, entering from the east, ran due west along Division St. and then turned southwest, crossing the New York Central Lines at grade. After extended negotiations, both railroads entered into separate contracts with the city in 1924, agreeing to elevate their tracks, to build about 25 street subways and to maintain separate stations. In 1928, however, an agreement was consummated between the city and the two railroad companies whereby the route of the Grand Trunk Western was to be altered so as to enable it to join the New York Central and use jointly with the latter company 1½ miles of its elevated line, as well as a new station to be constructed for the use of both railroads as a union station.

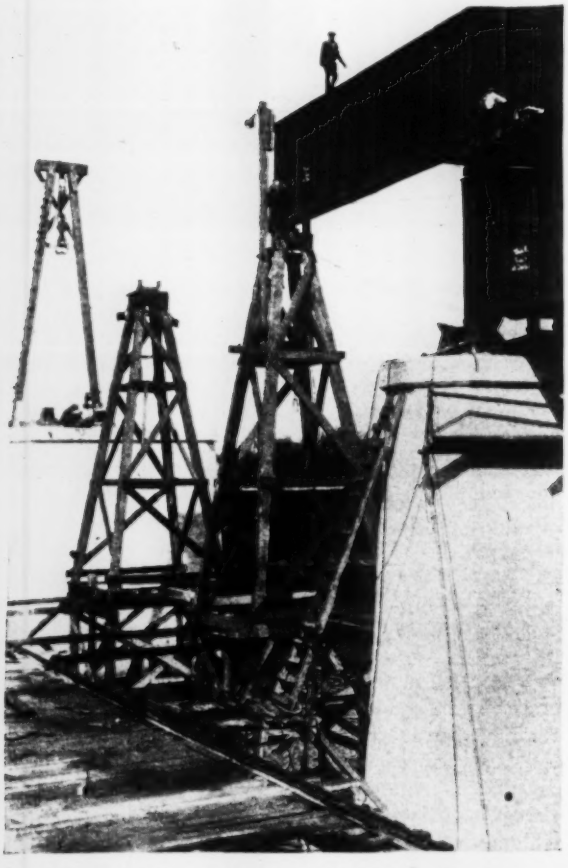


FIG. 1—LAUNCHING GIRDER FOR RIVER SPAN
Rear end held and pushed by locomotive crane, as forward end is outhauled by gallows frame. Temporary towers form intermediate supports.

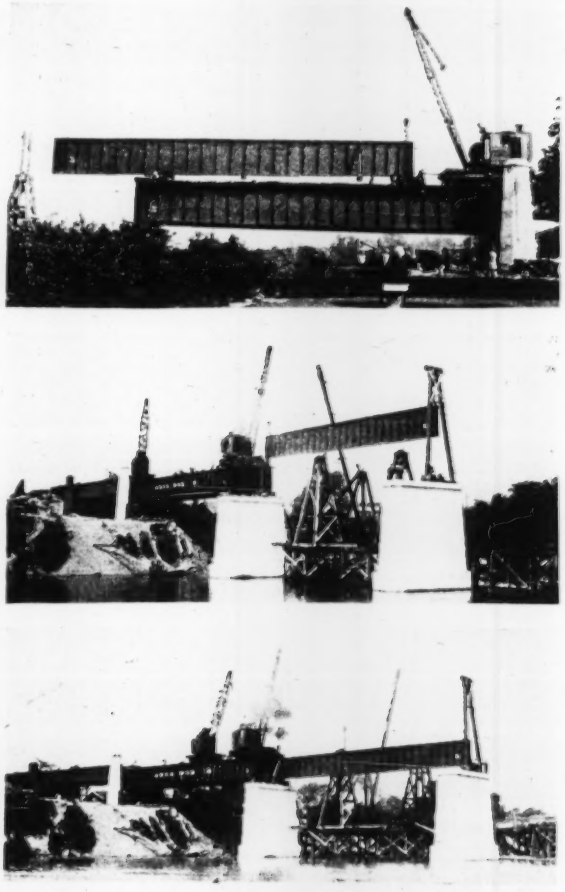


FIG. 2—ERECTING A GIRDER, ST. JOSEPH RIVER BRIDGE
Top—June 5, 4:20 p.m.; girder being pushed out on car trucks to first temporary tower. Middle—June 6, 10:40 a.m.; girder swung clear by crane and gallows frame and ready to be lowered when temporary tower is removed. Bottom—June 6, 10:50 a.m.; girder landed on its bearings.

Under this agreement the Grand Trunk Western has constructed 1.3 miles of double-track railroad, with all grade crossings eliminated, to connect with the New York Central and will divert its traffic to the new line and station early in October. On the Central, the track elevation has a length of about 2½ miles and consists mainly of an earthfill between concrete retaining walls, with steel bridges over the streets. The new union station occupies the site of the old New York Central station.

From the map (Fig. 3) it will be seen that on the east

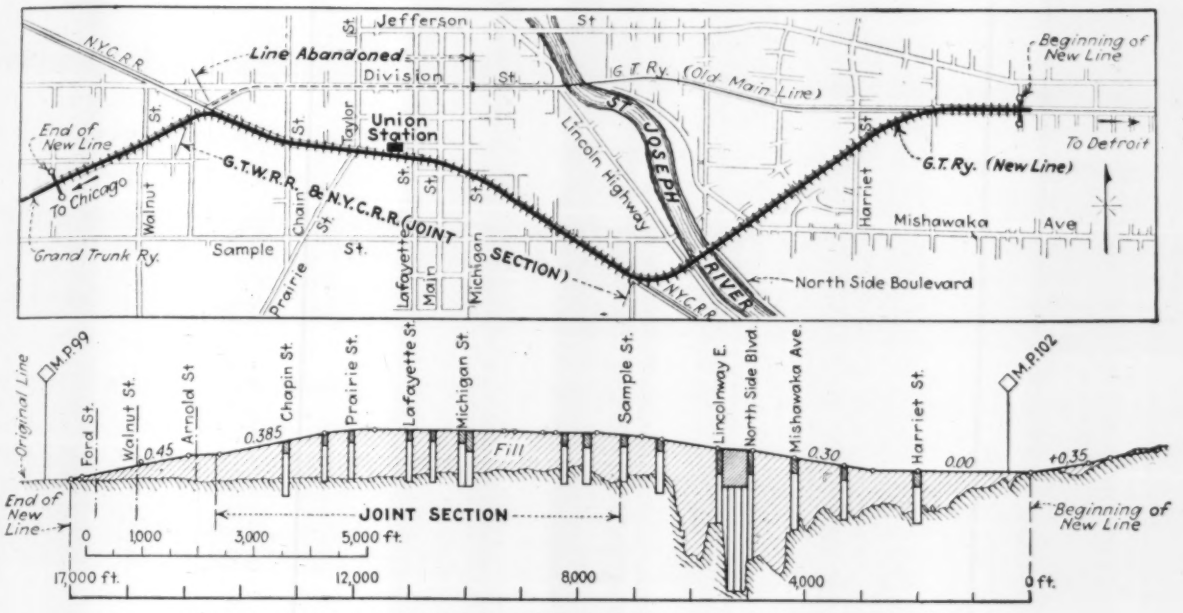


FIG. 3—RELOCATION OF GRAND TRUNK WESTERN RAILWAY AT SOUTH BEND, IND.

side of the St. Joseph River the Grand Trunk Western Railway had its own right-of-way, but that on crossing this river it entered Division St. and followed this thoroughfare to the western part of the city. As it had been proposed to extend the double-track through the city, the river bridge was completely rebuilt in 1910 as a double-track structure, but the second track was never laid across the river or through the city. Instead of this and in accordance with the agreement noted above, the railroad has built a new double-track line 1.3 miles in length, crossing the river farther south by a six-span bridge and connecting with the elevated tracks of the New York Central. It has joint use of this line for about 1½ miles, including the union station, and then diverges to its original right-of-way, descending to ground level by a fill with a grade of 0.45 per cent. The east end of the old line will be retained as far as Michigan St. in order to serve the freight house, team tracks and a group of industries, but beyond that point the tracks will be removed, in order that Division St. may be fully developed as a main thoroughfare.

Two principal structures on the new line are the St. Joseph River bridge and a concrete arch spanning Mishawaka Ave. On the eastern end of the line are two subway bridges having spans of I-beams (parallel with the tracks) incased in concrete and supported on concrete abutments and intermediate reinforced-concrete bents. All bridges have concrete decks and ballasted tracks. As this end of the new line is in a residential and park district, the slopes of embankments are dressed and covered with turf, thus giving a good appearance and preventing wash or erosion.

St. Joseph River Bridge—The new river crossing (Figs. 1, 2 and 4) consists of four 107-ft. plate-girder spans crossing the river channel and at each end a 90-ft. span, over the Lincoln Highway along the west bank and the North Side Boulevard along the east bank. These two shorter spans have the outer girders masked by a concrete fascia with decorative treatment and their piers are carried up as pylons to add to the architectural effect. In order to keep the grade line as low as practicable and still give the required headroom over the boulevards as well as to avoid girders of great depth, each span consists of four girders forming two single-track spans.

Substructure—The east bank was originally a swamp, covered gradually by 12 to 15 ft. of rubbish. Wooden piles were driven for the end pier and 50- and 60-ft. precast concrete piles for a cellular concrete approach behind it (see Figs. 4 and 5). All other piers and the west approach have footings direct upon gravel, but permanent steel sheetpiling 20 ft. long surrounds and is anchored to the footings of the river piers, so that there can be no movement or scour of the material beneath them.

The west abutment or approach, where there is a high approach fill, is a rectangular cellular structure buried in the earthfill. To tie the walls together and also to reduce the weight of inclosed fill, a deck is provided at mid-height. A top slab forming the sub-grade is cantilevered out on either side to form a walk and is curved on the

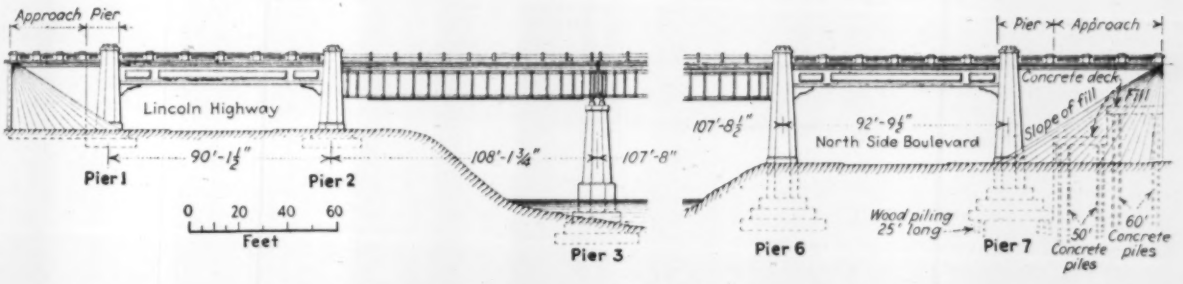


FIG. 4—ST. JOSEPH RIVER BRIDGE, GRAND TRUNK WESTERN RAILWAY

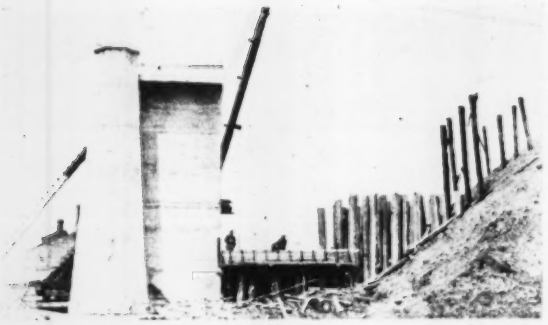


FIG. 5—EAST PIER, WITH CONCRETE PILES TO CARRY APPROACH

face to give a good appearance, conforming to the fascia treatment of the girders in the boulevard span. Solid parapet walls are built along the walks.

All piers are of mass concrete, reinforced on each face with scrap rail and having a double layer of rails in the base of footings. There is also a network of vertical and horizontal bars in the upper portion of each face to prevent temperature cracks. No ice-breaker nose is provided, as there is little heavy ice and the river current is swift. Concrete was made with washed gravel or crushed stone as coarse aggregate. After removal of the forms, the surface of all exposed concrete was finished with a grinding wheel and afterward received a coat of waterproofing followed by a cement application which leaves a white and dense surface.

Solid Floor on Steel Spans—In the 107-ft. river spans (Fig. 7), the girders are 10 ft. deep and 8 ft. center to center connected by the usual type of laterals and cross-bracing. The deck consists of a 17-in. slab of reinforced concrete, which rests directly on the top chords of the girders and extends slightly below their surface so as to form a lateral tie. But where it would come in contact with the connection plates of the lateral bracing, a ½-in. pad of felt is placed between the concrete and the steel. This slab forms a trough for the track and ballast and is cantilevered out 4 ft. 9 in. on the outer sides to form walks for the trackmen. Below the walk, the face of the slab is curved for the sake of appearance, to harmonize with the end spans and concrete approaches. Concrete posts along the edges of the walks carry a double railing of pipe with butt-welded joints.

On the track slab is a layer of waterproofing consisting of a two-ply fabric membrane with asphalt mopping. This is protected with a pavement of asphalt blocks 1¼ in. thick, upon which is placed the stone ballast, with a minimum depth of 12 in. under the ties. The surface of the slab is crowned and graded in drainage planes, leading water to a collector head with a 4-in. iron pipe or downspout placed between the inner girders and of such length as to discharge water clear of the steelwork. A slotted cap or inlet prevents ballast from entering the drainpipe. In the end spans, over the boulevards, the drainpipes are carried to the rear sides of the piers and are not exposed to view.

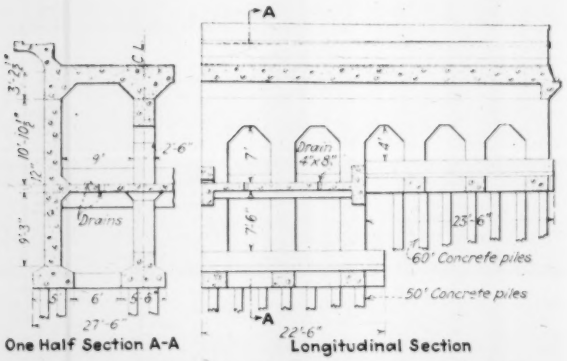


FIG. 6—CONCRETE APPROACH FOR EAST PIER

For the two 90-ft. boulevard spans, a half-through construction was adopted, in order to give the required headroom under the girders. Here the girders of each track are 8 ft. deep and 10 ft. 6 in. apart. For each track there is a floor of 21-in. transverse I-beams spaced 3 ft. and supported by standard beam connections to the girder webs. These beams are incased in concrete, forming a ribbed deck with top slab having a minimum thickness of 7½ in. at the center. The concrete is carried up over the tops of the girders and cantilevered out on each side, as in the river spans. But in order to give a satisfactory appearance from the street, the concrete is also extended down on the outside of each outer girder to form a paneled fascia. This concrete is reinforced by wire mesh attached to longitudinal rods carried through holes in the stiffener angles.

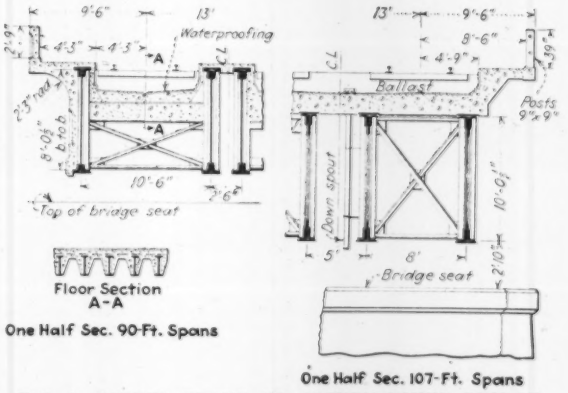


FIG. 7—GIRDER SPANS, ST. JOSEPH RIVER BRIDGE

Erection of Girders—In building the bridge, the spans for one track were erected first, working from the west end, the girders being delivered on cars through the joint section of line at this end. For the first or 90-ft. span, each of the two 53-ton girders was placed by a powerful derrick car with 60-ft. boom, which picked up the girder from its car and carried it out far enough to lower it upon its bearings. As this first span crossed the Lincoln Highway, which has a car line in addition to its other heavy traffic, no falsework or obstruction was placed in the street. Traffic was halted temporarily, however, during the placing of each girder, as a measure of safety.

For the 107-ft., 74-ton girders of the river spans, a launching arrangement was devised. At the first river span, each girder on its cars was run out on the 90-ft. span, the derrick car above mentioned then raising each end in turn so that blocking could be placed under it and the flat cars then withdrawn. Two car trucks were run into position and the girder landed upon them. A 50-ton locomotive crane, holding the girder by the boom, then pushed the girder out slowly, until its end rested on a timber tower at about one-third of the span. The forward truck was then removed. For the first 107-ft. span, a locomotive crane on the ground, with crawler traction, took hold of the forward end of the girder as it was pushed out to a second tower. A line from a gallows

frame on the pier then held the end of the girder for its third movement to the pier. Each tower had on its top a pair of well-greased horizontal iron rollers to support the girder and vertical guide rollers to hold it in line and prevent any lateral movement. To provide for this method of handling, the bottom chord of the girder was fitted with oak planking, notched for the cover plates and recessed for the rivet heads. This plank, having a minimum thickness of 2 in. and protected on the face by a steel plate, was bolted to the bottom flange.

For the next three spans, over the channel, the forward end of each girder was outhauled and supported by tackle from a gallows frame on the farther pier. The rear end was held by the boom of a locomotive crane on the track, as the crane pushed the girder out on its trucks, until it was supported by the two timber towers. When the girder reached the farther pier, it was held suspended from the crane and gallows frame and lowered into position on its bearing. Piles were driven to support the temporary intermediate towers. In the bottom view (June 6, 10:50 a.m.), the girder has been landed on its bearings.

Concrete Arch Span—For the crossing of Mishawaka Ave., which has a double-track electric car line, a barrel arch bridge was adopted, having a clear span of 70 ft., with a headroom of 20 ft. at the center and 13½ ft. at the gutters of the 54-ft. roadway. The springing line is about 6 ft. above the sidewalk. As the crossing is at an angle of 71 deg., the actual span parallel with the railroad is 74 ft. At the site 10 to 15 ft. of gravel is underlain by 15 to 18 ft. of stiff clay. The abutments are of cellular construction, with creosoted wood pile foundations and sand filling to subgrade. A double layer of scrap rail is placed over the piles and similar rail is used also in the abutments, as shown in Fig. 8. Views of the construction of the bridge are given in Fig. 9.

The arch barrel has a radial thickness of 4 ft. 6 in. at the haunches and 2 ft. 6 in. at the crown. Grooves at

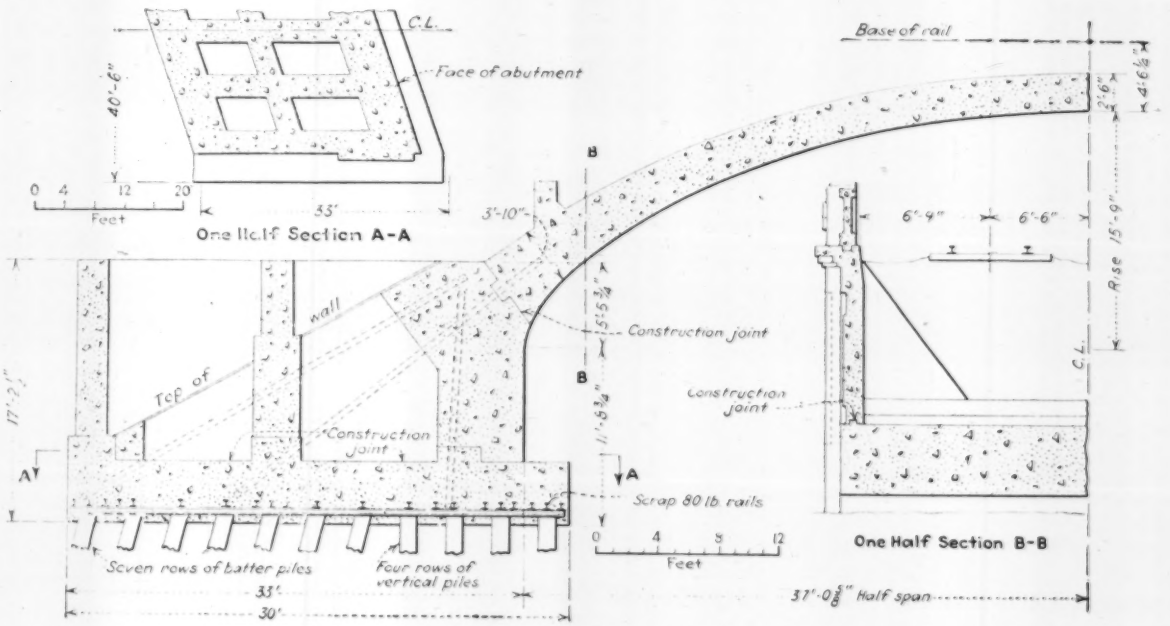


FIG. 8—ARCH SPAN OVER MISHAWAKA AVE.

temporary timber towers in the river spans. These towers were not dismantled, but were picked up and carried from one span to the next by a derrick traveling on a low construction trestle on the downstream side of the bridge. When one span for the westbound track had been erected and field riveting completed, the girders for the eastbound track were brought ahead and placed in position by the same methods.

These erection methods are explained by the illustrations Fig. 1 and 2, which show the work on span No. 3, or the second river span. In Fig. 1 (June 5, 1929, 4:30 p.m.), the first girder has been run out as far as the first tower. At the left is the gallows frame on the farther pier, the tackle of which is operated from a hoisting engine on the farther or eastern bank. In the top view of Fig. 2 (June 5, 4:20 p.m.), this first girder is being pushed out by the locomotive crane, the girder riding on the car trucks. In the middle view (June 6, 10:40 a.m.), the girder has been swung clear, being held by the locomotive crane and the gallows frame, while a derrick traveling on the construction trestle is removing one of each side form mortise joints for the spandrel walls, the tops of which have similar joints for the parapet. Gussets or counterforts extend from these walls to the surface of the arch. The barrel of the arch is waterproofed with a membrane of fabric with asphalt mopping, and upon this is a protective coat of asphalt block covered with a 6-in. bed of broken stone for drainage of the slag fill. Iron drainpipes are also laid in this stone layer. The spandrel walls and parapets are relieved by recessed and bush-hammered panels. For concrete finish, the exposed surfaces received the same treatment as the river substructure. To retain the slopes of the approach fills and prevent material from sliding over onto the sidewalks, there are circular curb or toe walls, 8 in. thick. These are 5½ ft. deep and project 2 ft. above the ground line, similar to those at the fills of the river bridge, shown in Fig. 7.

In the construction of this bridge, the concrete of the abutments was placed by spouting from a bucket in a hoisting tower. For the arch itself and the spandrel walls, a narrow-gage track was laid along the falsework,

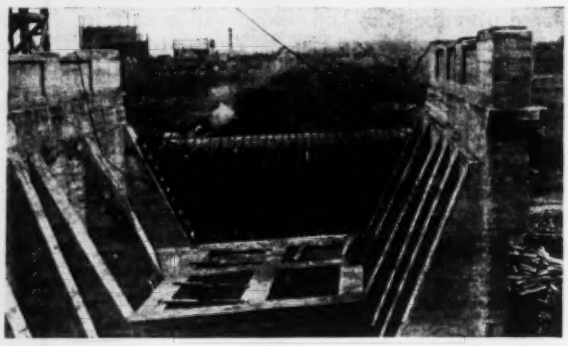


FIG. 9—CONSTRUCTION OF ARCH BRIDGE
Above—East abutment and first section of arch. Below—cellular abutment, with reinforcing steel placed for 70-ft. arch.

on the side adjacent to the tower, and on this ran two steel bottom-discharge hopper cars, pushed by hand. They were loaded from the hoisting bucket and dumped the concrete into portable chutes leading to different parts of the form, as required. The street-car tracks were gantleted by means of temporary portable turnouts, the permanent tracks and street paving being laid after the bridge was completed.

Engineers and Contractors—Both design and construction of the new line and its structures were under the direction of J. A. Heaman, chief engineer; F. P. Sisson, principal assistant engineer, and A. N. Laird, bridge engineer, of the Grand Trunk Western Railway, with W. G. Heggie in charge of the field organization. The grading was handled by Whitman & Keller, South Bend, Ind., and the Walsh Construction Company, Davenport, Iowa; the concreting and steel erection for the river bridge and the Mishawaka Ave. arch was done by Foley Bros. and Fulton & Peppard, St. Paul, Minn. Concrete finishing and surface waterproofing was done by the Wertz Company, Cleveland, Ohio. Two subways were built complete by the Mead-Balch Construction Company, Indianapolis, Ind. All superstructure steel was fabricated and furnished by the American Bridge Company. The total cost of this Grand Trunk Western Railway project was about $1,800,000. Of this cost, the city paid $671,000, a portion of this sum being contributed by the city in consideration of the Grand Trunk Western relinquishing its rights in Division St. and joining with the New York Central for its line through the city, thus eliminating the situation of two railroads traversing the city with a multiplicity of grade separation structures, while also providing the additional advantage of a union station. In addition to the above, the city paid 25 per cent of the cost of work at street crossings where grades were separated, in accordance with the requirements of the Indiana law.

Chemical Treatment of Hydraulic Dam Cores

Physical Chemist and Engineer Develop an Application of a Colloidal Phenomenon of Clays

By F. E. Hance
Honolulu, Hawaii

RESEARCHES in Honolulu on soil materials available for dam construction have brought out an important practical possibility of utilizing colloid phenomena known to the physical chemist. Some specific results shown by these studies are:

1. Surface deposits of many mountain soils are highly acid in reaction, and when classified according to the scheme of Dr. Charles Terzaghi they fall within the limits of sandy loams or silts.

2. When agitated with water many of these soils fail to impart their acidity to the water, and a condition of semi-permanent dispersion of soil in water is frequently obtained.

3. An acid soil which will produce a dispersed semi-permanent cloudy mixture with water will, upon neutralization with alkali, immediately flocculate and settle out, forming a well-defined and granular deposit under the clear water remaining above it. Under the Terzaghi tests the precipitated and neutralized soils resulting from this treatment are classified now as sandy silts and are much more permeable, more granular and also carry a greater percentage of voids than the same material in its natural acid condition as first described.

4. When treated with enough alkali to produce a soil reaction of about 10 on the pH scale (15 to 35 lb. Na_2O per ton of soil), the precipitated neutral soil described in the preceding paragraph is altered by the treatment so that it falls within the classification of the fat clays. In addition this alkaline-treated soil has become from 200 to 1,000 per cent more impermeable than the same material when neutral. The voids have been reduced to a remarkable extent, and the physical appearance is suggestive of a very sticky and heavy clay.

The relatively small amount of alkali (soda ash) required to produce this effect on the colloidal structure of the soil, affecting to such a marked extent its permeability and reduction in voids, has led the writer to propose:

(*a*) That further research be encouraged with systematic studies on the physical and chemical properties of soils in relation to its usefulness to the engineer in foundation problems and in special problems of core trenches in dams.

(*b*) That a field of usefulness to the engineer may be developed from other physical chemical tests and consequent predictions as to consolidation, stability, etc., now in vogue in this laboratory.

(*c*) That the free-flowing and highly impermeable yet readily consolidated alkali-treated soil be employed as a fill in a wedge-shaped trench immediately surrounding a concrete cutoff wall, the latter carried down to bedrock through a stratum of gravel beneath the foundation of a dam.

Practical application of the alkali treatment is now being made in actual construction of the dam in question. Fuller details will not be available until later.

The object of this memorandum is to state a premise

which will later have to be withdrawn or substantiated—certainly not modified. The theoretical considerations involving the treatment are not new, but the application of the idea to a particular engineering problem in Hawaiian soils is perhaps somewhat of an innovation. A second purpose of the memorandum is to stimulate discussion among engineers on the importance of using the tools of the physical chemist in foundation problems.

Specific application of soil and colloid studies to individual engineering problems will appear in a later paper.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Tests on Concrete—Correction

Sir—I wish to call your attention to two errors occurring in the first sentence of the article on "Tests on Concrete Made at Coolidge Dam" which you published in the Sept. 19 issue.

As published, the sentence read: "The water-cement ratio theory is in the spotlight at the present time whenever the subject of concrete making is under consideration, and there are a few who deny its importance of practicability when intelligently used."

It should have read: "The water-cement ratio theory is in the spotlight at the present time whenever the subject of concrete making is under consideration, and there are few who deny its importance or practicability when intelligently used."

This error makes quite a marked difference in the meaning of the sentence.

BRUCE JOHNSTON.

Champaign, Ill.,
Sept. 23, 1929.

Badly Crushed Columns Uncovered in One of Detroit's Largest Buildings

Sir—One might draw two morals from the accompanying illustrations: One that there is more to design than the figuring of stresses and that conditions arise that are very difficult to foresee; the other that a structure will usually stand if in any way by any stretch of the imagination it can can be figured to stand. Not that either of these observations are new, but the illustrations and conditions lend them emphasis.

OLD BUILDING COLUMN IN DETROIT

These columns, although more than half, probably three-quarters, of the section is gone and the remainder is bent and crushed from the load, are still doing duty in one of the largest of Detroit's buildings, but are rapidly being replaced.

The columns (two and possibly three out of five are about as shown, the third not having been uncovered) went up through a boiler wall between two fireboxes. They were apparently close enough to the heat and corrosive gases to have been damaged thus seriously in a period of eleven years. Eleven years ago they were reinforced at this point due to the same action.

This time they are being removed entirely, the upper portion being carried by girders above the boilers.

Detroit, Mich.,
Aug. 31, 1929.

W. O. HINKLEY

Strain and Stress Measurements in Concrete Arch Bridges

Sir—Mr. Slack is to be commended for the efficient manner in which he has planned and carried out the measurements of the 160-ft. concrete arch bridge reported in your issue of Aug. 29, p. 336. The results may be accepted as authoritative. There is a question, however, whether researches have progressed far enough to enable anyone to forecast the full significance of the tests.

It is apparent to the writer that the "flow" or "time yield" of concrete is a controlling factor in an interpretation of the results. Mr. Slack reports that the observed stresses were higher than computed stresses in both steel and concrete. His reduction of deformations into stresses in steel is doubtless correct. Such a definite statement concerning concrete stresses is not justified by the available information. The impression is given that a modulus of elasticity which was determined by usual laboratory methods in a comparatively short time was used directly in transforming long-time concrete deformations into stresses.

The writer, in joint work with C. C. More, was confronted in 1915 with a similar problem in interpreting the stresses in a reinforced-concrete warehouse in which deformations had been determined. In this case, deformations were observed in the building, with no signs of distress, which exceeded those in the laboratory specimens at impending failure. It became apparent, to quote from the report (*Proceedings* Pacific Northwest Society of Engineers, Vol. 15 (1916), No. 1; also published in modified form in *Proceedings* American Concrete Institute for 1916) that "the modulus of elasticity as a measure of the relation of stress to deformation while the load is being applied or released is of doubtful value in interpreting the stresses that are represented by the observed deformations in the building. However, the modulus of elasticity as a measure of the relation of stress to deformation as determined from time tests in which the rate of application of the load is the same as in the building would furnish means for making a fairly satisfactory forecast of the existing stresses." Time tests were made, therefore, in the laboratory which extended over as many days as the building was under load and with unit stresses which approximated, for each day, the normal maximum of those in the building. These tests gave a fairly satisfactory basis for the interpretation of the stresses in the building.

It will be noted from Fig. 4 of Mr. Slack's paper that, while the observed stresses in the steel usually exceeded the computed stresses as was stated, the two were approaching each other at the end of the period of obervation. It is hoped that further results will be available.

The concrete, as a semi-elastic but partly plastic substance, was undergoing changes, including slight permanent deformations under load, during the four months of observation that cannot be fully understood. These changes lead the writer to make a different interpretation than was made in the stresses in the concrete from the loads and in the temperature stresses. It does not seem unlikely that, as the high temperatures occurred during the first ten days before the concrete had reached its full strength, a natural "time-yield" gradually took place and, as a result, a freedom from temperature stresses occurs under conditions much nearer normal

temperatures than the high temperatures which were developed while the cement was in the process of setting and hardening.

Mr. Slack's paper again emphasizes the need for further research concerning the long-time behavior of concrete under continuous load.

A. H. FULLER,
Professor of Civil Engineering,
Iowa State College.

Ames, Iowa,
Sept. 4, 1929.

* * *

Sir—With reference to Professor Fuller's stimulating comment the following is quoted from the second paragraph of the article: "An ideal set of stress measurements for an arch rib should show the total stress in both steel and concrete at the critical sections . . . Such an ideal set of stress determinations cannot perhaps be attained with present methods based on measurements of strain and conversion of these into stress by multiplying by the modulus of elasticity, because in the early stages of the work or over a long period of time there is much evidence to show that strains in concrete are not directly proportional to stress."

It was the writer's intention to state in this paragraph the recognized discrepancies to be expected in stress measurements in concrete which depend upon conversion of strain into stress. While there is little definite knowledge about the internal adjustments, or so-called "flow," in concrete due to setting and drying out phenomena or to long-time stress, it seems to be generally agreed that these internal adjustments exist. The ample strength and close agreement between measured and computed stresses in the North Carolina full-size arch tests would appear to be the best evidence that in some way the initial and temperature stresses had largely adjusted themselves.

No definite range of temperature was suggested in the conclusion that design of concrete arches should be based entirely upon a fall in temperature. While the data indicate a possible range of from 110 deg. F. to 35 deg. F., a total fall of 75 deg. F., it was not the writer's intention to suggest the use of such large temperature stresses as would be caused by so great a fall in temperature. Some of this stress must be relieved by internal adjustment in the concrete. Just what fall in temperature should be allowed in design to approximate temperature stresses should be determined by further research, but 60 deg. F. would seen conservative. This range would not seriously affect temperature stresses except in rather flat arches, and it is generally suspected that high stresses exist in this type of structure.

Further research is needed on initial stresses and subsequent internal adjustment in concrete. O for a method of measuring stress in concrete without having to depend upon strain!

If this piece of work and report does emphasize the need of further research work and will create a doubt in the minds of engineers who smugly assume that their arch analyses are strictly correct, then I shall feel more than repaid for the effort made.

SEARCY B. SLACK,
Bridge Engineer,
State Highway Department of Georgia.

East Point, Ga.,
Sept. 10, 1929.

Grade Eliminations on Rural Highways

Sir—Your issue of Sept. 5, 1929, contained an article by Professor Kittredge on "The State's Larger Share in Grade-Crossing Improvement." Your editorial note at the head of this article says: "Bold assertion is made in this article that the public often enjoys greater financial gain than does the railway through grade-crossing elimination and protection, and therefore is under obligation to contribute more liberally toward the cost."

As the writer views the situation as it affects grade eliminations on rural highways, on the basis of financial benefits the railroads would be obligated to pay but very little, for actually their financial benefit is little or nothing. Particularly is this true since the well-known Supreme Court decision throwing the burden of caution on highway traffic in crossing a railroad. Railroad trains do not stop for highway traffic, and move on just the same whether over a crossing at grade or on a separation structure. It is highway traffic that must stop, if necessary, says the Supreme Court. It is highway traffic that generally gets the small end of the bargain in disputing the right-of-way with locomotives on grade crossings. It is highway traffic that reaps the big benefit when grades are separated.

In the days before the automobile when traffic on rural highways was very light and time was less valuable than today, there was no great agitation for elimination of grade crossings in rural areas. No one can dispute the statement that it is the enormous increase in highway traffic since the advent of the motor vehicle that makes it necessary to eliminate railroad grade crossings. The demand is from the users of motor vehicles, which includes all of us, the public. And it is the public, and not the railroads, that will reap the big financial benefit. Hence if costs are to be apportioned according to benefits between the railroads and the public, it is the latter which should pay practically all the costs of grade-crossing elimination.

At this point the writer pauses, to listen, as it were, to the cheers of those who receive their pay checks regularly from the railroads and to the loud protests of those servants of the public who have something to say about the expenditures of public funds for highway purposes.

There is another side to the argument, overlooked in the article referred to and the editorial comment thereon. Those presenting the state's side of this case refer to a term, "the police power of the state." They make bold to say that the railroads are not the public. Although they are public utilities, they are nevertheless private corporations organized for profit. Where new railroads are being built they point out cases where the courts have held that the entire cost of separation must be paid by the railroads. The state, exercising its "police powers," they assert, can compel a railroad to eliminate an existing grade crossing and has the power, moreover, to enact legislation to make the railroad pay the full cost thereof. The theory is that the state can require the railroads as private corporations with no prior rights on public highways to make such changes in their mode of operation as to take care of the needs of the public using the highway. If this latter theory were carried to its logical conclusion, the state would at no time pay anything toward the cost of grade elimination where highways existed prior to the railroad.

As a matter of fact the writer knows of no place where grade-elimination work is being financed and the costs apportioned (1) "according to benefits" or (2) at the full expense of the railroads at the mandate of the "police power" of the state. It is the writer's opinion that the only way in which grade-elimination work can proceed in this country is on the basis of a compromise between the two radical views herein outlined.

You have well said, "The time is here when the rights of traffic to unimpeded and safe service is paramount to jealousy of private property rights or to demagogism in public office."

HARRY J. KIRK,
Consulting Engineer.

Columbus, Ohio,
Sept. 17, 1929.

Bakery Engineers

Sir—Although you poke a little mild fun at this Institute, its members really are engineers, combining the specialties of the mechanical engineer and the heating and ventilating engineer. They are mainly, I believe, the engineers of the big wholesale baking companies. Some time ago one of them read an elaborate paper before the Western Society of Engineers, on the design, experimental work, construction and operation of a baking plant where the dough—untouched by hand—is delivered to molds on a conveyor traveling through an oven with heat so regulated as to insure baking to the heart of the loaf without causing a heavy or hard crust. This requires very definite regulation of temperature and speeds, with complicated mechanism and delicate regulating devices. So the bakery engineer is not quite in the same class as the "bug exterminating engineer" or the "tonsorial engineer."

ENGINEER.

Chicago, Ill.,
Sept. 20, 1929.

News of the Week

Company Is Overcharged for Niagara Water, City Claims

Contending that its industrial prospects may be affected adversely, the city of Niagara Falls, N. Y., on Sept. 28 obtained from Supreme Court Justice Nichols in Albany a writ of certiorari directing the state Water Power and Control Commission to show why it assessed $50,000 rental against the Niagara Falls Power Company for the use of 500 sec.-ft. of water in a decision rendered June 27 last.

The question of the amount of rental to be assessed by the state for use of the water has long been troublesome, and was first taken up actively in 1925 by the commission, which fixed an annual rental of $60,000 for 4,400 sec.-ft. diverted by the company under international agreement.

The additional 500 sec.-ft. diversion was made possible after revision of the international treaty and brought up again the question of rental. In fixing the amount at $50,000, the commission stated that the total rental charge of $110,000 for a full total of 4,900 sec.-ft. diverted was a fair and equitable charge for Niagara's power.

Large Group of Engineers Starts for Tokyo Congress

A farewell dinner in honor of the foreign and American delegates to the World Engineering Congress in Tokyo was held in New York Sept. 26. The foreign delegates present included a large Italian delegation and a lesser number from England, Sweden, Germany and Canada. Both Frank Gill, vice-president of the Institution of Electrical Engineers, London, and Senator Luigi Luiggi, honorary president of the State Council of Public Works, Rome, spoke at the dinner. The party starts by special train from New York Oct. 3, stopping at Washington and Chicago en route for San Francisco, where they will be met by other delegates for sailing on Oct. 10. The passenger accommodations of two ships will be required for the entire party.

Indiana City Manager Law Held to Be Unconstitutional

In a decision handed down Sept. 24, the Indiana Supreme Court declared unconstitutional the city manager law under the provisions of which the citizens of Indianapolis had recently adopted the manager system by a 6 to 1 vote. When the petition for this election was filed in 1927 it contained 19,000 signatures, which the city clerk, under the terms of the statute, was required to verify within five days. The task was accomplished by employing assistants. The court, however, has ruled that this is a judicial function of the clerk's office which cannot be delegated. Since it is manifestly impossible to check 19,000 names in such a short time, the law lacks universal application throughout the states and is therefore contrary to the Constitution.

Besides Indianapolis, the only other place in the state affected by the decision is Michigan City, which has had a city manager for the past eight years.

Appointment of General Brown Confirmed by Senate

The Senate on Sept. 30 confirmed the nomination of Gen. Lytle Brown to be Chief of Engineers of the United States Army. This action followed the consideration of the nomination by the military affairs committee, in the course of which General Brown appeared in person. There was unanimous support for a favorable report on the nomination.

MAJOR-GEN. LYTLE BROWN

Since his nomination General Brown has been discharging the duties of the Chief of Engineers. Gen. Herbert Deakyne, who had been acting Chief of Engineers since Aug. 7, reassumed his duties as Assistant Chief. There are rumors that a number of engineer officers who are older in the service than General Brown will request retirement. It is pointed out, however, that these officers were jumped when General Brown was assigned to the line of the army. At the time of his appointment, in the strict interpretation of army practice, he was the superior in rank of every engineer officer except General Deakyne.

Georgia Power Co. Plans New Dam on Oconee River

Plans for the immediate construction of a hydro-electric development of 60,000-hp. capacity on the Oconee River at Furman Shoals, 4 miles north of Milledgeville, Ga., have been announced by the Georgia Power Company. Work is expected to start at once on the project, which is scheduled for completion by the middle of 1931. A concrete dam 90 ft. high totaling 3,000 ft. long with earth abutments will create a lake covering 12,000 acres and having a storage capacity of 5½ billion cubic feet. Two 30,000-hp. turbines will be installed in the plant. The new development will supply power to the Macon and Augusta divisions of the company.

Model Law for Air Traffic Proposed for Local Use

In an effort to secure uniform regulation of air traffic, the U. S. Department of Commerce has prepared a model aeronautic code which will be submitted to state legislatures for enactment. Under the provisions of the air commerce act, the federal government, through the Department of Commerce, can regulate only aircraft and airmen engaged in interstate commerce; all others can be reached only by state or municipal regulation. The model ordinance has been drawn up in the hope that it will be adopted by all such authorities. In substance, the model law provides that the local authorities require compliance with federal regulations as regards licensing and operation.

The department has also brought out a set of suggested field rules for airports which, if generally adopted, will eliminate from air traffic much of the confusion sure to result if independent regulations are adopted at each airport.

Large Irrigation Dam Completed in Mexico

Construction of a large dam on the Lerma River near the town of Tepuxtepec, Michoacan, Mexico, by the Mexican Light & Power Company, Toronto, Canada, is nearing completion. This company and the Mexican National Irrigation Commission are co-operating in a combined flood-control, hydro-electric and irrigation project involving an investment of approximately $10,000,000 which will reclaim more than 100,000 acres of arid land in the states of Michoacon and Guanajuato. Electrical energy from a power house now under construction will be used by the Southwestern Light & Power Company of Mexico, a subsidiary of the Mexican Light & Power Company. The dam stores about 500,000,000 cu.m. of water.

Application for Power Permit by Seattle Utility

Application has been filed in Olympia, Wash., with the state hydraulics supervisor by the Puget Sound Power & Light Company, Seattle, for permission to appropriate 1,060 sec.-ft. of water from the south fork of the Skykomish River in eastern Snohomish County, Wash., for a power development project.

The plant, which would have an output of 20,500 electrical horsepower and be built at an estimated cost of $1,825,500, would be located about a mile east of the town of Index and near the confluence of the north and south forks of the river. A concrete diversion dam 15 ft. high and 300 ft. long would be built, and a fall of 170 ft. would be utilized in the project.

Street Sanitation Officials to Discuss Problems

The tenth conference of the International Association of Street Sanitation Officials will be held in Jacksonville, Fla., on Oct. 14-16. Some of the subjects to be discussed and those who will present them are:

"How Should Vehicles Pay for Street Maintenance—Vehicle Tax—Gas Tax," L. W. Herzog, commissioner of public works, Albany, N. Y.; "Municipal Asphalt Plant and Asphalt Repairs," Edwin A. Miller, superintendent of maintenance, department of public works, Rochester, N. Y.; "What Does the Future Hold for Garbage Collection and Disposal?" Carl Schneider, aid to commissioner of public property, New Orleans, La.; "Generation of Steam at a City Incinerator," William Sydow, superintendent, division of waste, Miami, Fla.; "Dust Prevention on Unpaved Streets," Matt S. Murray, director of public works, Kansas City, Mo.

Impeachment Urged for Highway Commission and Engineer

The Grand Jury of Franklin County, Ky., has recommended that the legislature at its next session impeach members of the state highway commission and the chief engineer. One of the commissioners, Ben Johnson, chairman, is exonerated. The Grand Jury alleges instances of "corruption, fraud, favoritism, discrimination and bribery" such as cannot be reached by indictment but should be handled by impeachment proceedings.

Much of the power of the chairman, the Grand Jury says, has been assumed by the chief engineer, J. S. Watkins.

The case of a resident engineer who received $150 in cash from a contractor and that of another engineer who "insisted" that a contractor sign with him on a note for $1,000, which the contractor subsequently paid, were cited, as was the practice of requiring applicants for employment to state their politics and religion.

Ralph Modjeski Receives John Fritz Medal

Announcement was made Sept. 27 of the award of the John Fritz gold medal to Ralph Modjeski "for notable achievement as an engineer of great bridges combining the principles of strength and beauty." The award was made unanimously by a board composed of sixteen past-presidents of the four founder societies.

Mr. Modjeski was born in Cracow, Poland, in 1861 and came to this country with his parents in 1876. His engineering education was obtained at the Ecole des Ponts et Chaussées in Paris. On returning to the United States he was engaged as designer, construction engineer and consultant on many of America's most notable bridges, including the McKinley bridge over the Mississippi River at St. Louis; the Columbia bridge at Celilo, Ore.; the Keokuk bridge over the Mississippi; the Ohio River bridge at Cincinnati; the Thames River bridge at New London, Conn.; the Quebec bridge; the Poughkeepsie bridge; the Philadelphia-Camden bridge; and the Manhattan bridge at New York. In 1911 he received the degree of Doctor of Engineering from the University of Illinois.

Steel Erection on Kill van Kull Bridge About to Start

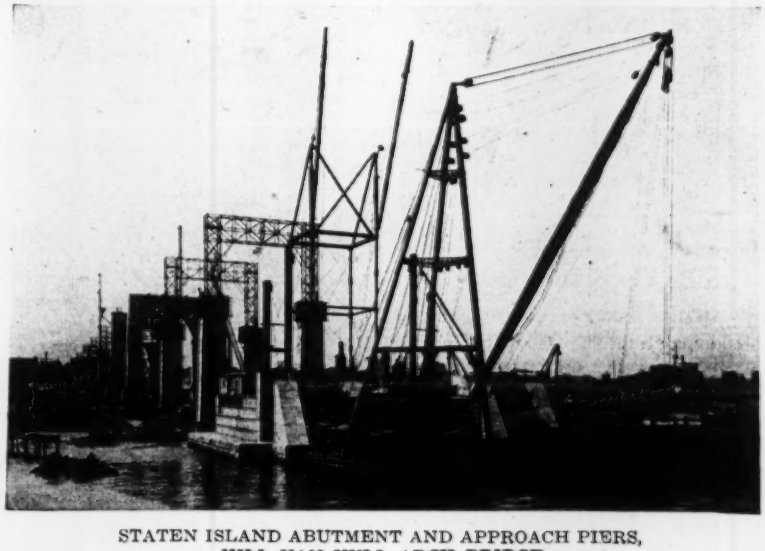
The American Bridge Company has about completed building the main arch traveler for the Staten Island end of the 1,675-ft. Kill van Kull bridge between Port Richmond, N. Y., and Bayonne, N. J., and is ready to start erection of the main span. Four steel falsework towers will be built on the New York end and six similar towers on the Bayonne end. Because the main channel of the Kill passes under one side instead of the center of the arch, the erection will be unsymmetrical, cantilevering about 291 ft. beyond the last falsework pier on the New York end and about 415 ft. beyond the last Bayonne falsework tower. Erection work will be carried on from the Staten Island abutment only until next spring.

Concrete work on the approach piers is 75 per cent completed on the Port Richmond side and 50 per cent completed on the Bayonne side. The piers, twenty on the New Jersey approach and nineteen on the New York approach, are hollow concrete structures reinforced with structural steel cages, similar to the design of the approaches of the Goethals and Outerbridge crossings between Staten Island and New Jersey. The Arthur McMullen Company is contractor on the New York approach and the P. S. Cox Contracting Company has the contract for the Bayonne approach piers. The H. P. Converse Company built both abutments for the arch.

American Irrigation Methods Adopted by Soviet

Modern American irrigation methods will be utilized by the Soviet government in Russian Turkestan to enable the country to produce sufficient cotton to supply its needs. Arthur Powell Davis, formerly head of the U. S. Reclamation Service, will supervise the work, which will entail the expenditure of 500,000,000 rubles (about $250,000,000) during the next five years. It is expected to make fertile an arid section as large as the State of Massachusetts.

Mr. Davis, who built the East Bay Utility District irrigation project in California, which supplies water to nine cities, including Oakland, Berkeley and Alameda, will have 30 American irrigation engineers under him.



STATEN ISLAND ABUTMENT AND APPROACH PIERS, KILL VAN KULL ARCH BRIDGE

Light Railways Association Meets at Warsaw in 1930

The next meeting of the International Association of Street Railways, Light Railways and Motor Transport will be held at Warsaw, Poland, June 29 to July 6, 1930.

Among the technical subjects on the program are the following: (1) electric transmission and feeder systems; (2) improvements in car and motor coach construction; (3) oil-engine traction on railways and roads; (4) track construction and paving; (5) co-operation of tramways, light railways and motor coach service; (6) comparison of surface and underground rapid-transit lines; (7) storage-battery cars; (8) electrolysis; (9) automatic block signaling for single-track lines.

Cape Girardeau Bridge Company Defaults on Bonds

The Cape Girardeau Bridge Company, owner of the new $1,600,000 toll bridge spanning the Mississippi River at that town, has defaulted in the third semi-annual interest payment on a $1,000,000 bond issue. In conveying this information to bond holders, the William R. Compton Company, St. Louis, one of the brokerage firms that underwrote and sold the bonds, attributes the default to the failure of the State of Illinois to complete its roadbuilding program as outlined under the administration of Governor Small.

The brokerage firm's letter to the bond holders states that at the time the bridge was started in the spring of 1927 assurance was given by Governor Small and officials of the Illinois Highway Department that 25 miles of hard road would be constructed, connecting the east approach of the bridge with the highway system of Illinois. Meanwhile, Governor Small was defeated for re-election and a shortage was found in the road funds which has held up the promised work.

The letter points to the gasoline tax, which will provide funds for road construction, as a probable solution of the problem.

Third Hurricane in Three Years Sweeps Bahamas and Florida

For the third time in three years the Bahamas and the Florida east coast were swept by a severe hurricane that originated in the West Indies Sept. 25, wrought havoc at Nassau, passed by the Palm Beaches, Fort Lauderdale, Miami and Homestead, crossed the Keys, and according to latest reports is moving slowly but with unabated fury along the Gulf coast. Incomplete reports from Nassau indicate that the most serious damage was done there, with an estimated loss of life of twenty and nearly every building in the city damaged. Minor property damage and no loss of life were reported by Florida cities, compared with the tremendous damage done by similar storms a year ago and in the fall of 1926, with a loss of 1,000 and 500 lives, respectively.

Fearing a repetition of last year's flood, many residents of the northern Everglades area fled from the southern shores of Lake Okeechobee to higher ground north of the lake. As the storm turned south instead of coming inland from the coast, the Glades area escaped harm. In 1926 and again in 1928 the regions surrounding the south shore of the lake were inundated by water blown over the levees. The lake level was El. 18.5 at the time of the 1926 storm, El. 16 last year, but was only at El. 13.8 this year. The levees along the south shore are now about El. 22.

Rainfall in Georgia and both the Carolinas was exceedingly heavy, following ten days of rainy weather. Precipitation at Raleigh, N. C., was 6.75 in. in 24 hours, with rain still continuing. Although many of the large rivers were already out of their banks, no structures had been reported lost at the time of going to press.

Missouri Raises Salaries of Highway Engineers

The salaries of engineers, division engineers and bureau chiefs of the Missouri State Highway Commission have been increased under an amendment to the state highway law that became effective on Aug. 27. Under the new law the commission is authorized to regulate the salaries of its employees up to certain maximums.

Under the new schedule State Highway Engineer T. H. Cutler was raised from $7,500 to $10,000; Assistant Chief Engineer Carl W. Brown from $5,000 to $7,500; acting Chief Counsel John W. Mather from $3,600 to $4,200; C. P. Owens, engineer of maintenance, from $4,800 to $5,100; L. T. Powers, engineer of surveys and plans, from $4,800 to $5,100; F. V. Regal, engineer of materials and tests, from $4,200 to $5,100; N. R. Sack, engineer of bridges, and D. B. Levi, engineer of construction, each from $4,200 to $4,800; J. A. Anderson, superintendent of equipment, and Claude Stuckey, auditor, each from $3,900 to $4,200.

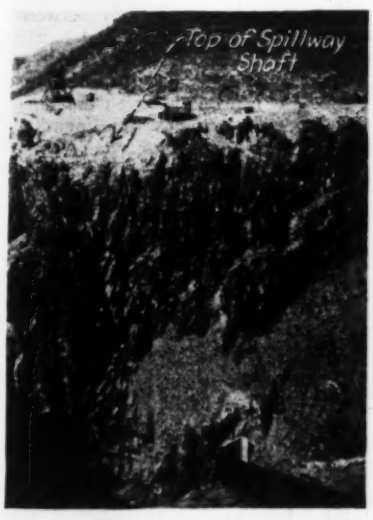
Division engineers received increases as follows: H. M. Brush, S. M. Rudder, H. P. Mobberly and George L. Clark, each from $3,600 to $4,200, and R. W. Hodson, D. D. Griffith, J. J. Corbett, P. H. Daniels and C. W. Francisco from $3,600 to $3,900 each.

New Grain Elevator Planned at Churchill, Canada

A 2,000,000-bushel grain elevator will be built at Churchill, the northern terminus of the Hudson Bay Railway, it is announced by the Canadian Minister of Railways and Canals. Foundation work will be started next summer and the elevator will be available by the fall of 1931. It is also announced that construction on the railway is nearly a year ahead of schedule.

Dredging is proceeding rapidly at the harbor at Churchill, an average of nearly 6,000 cu.yd. daily having been removed during the season.

OWYHEE DAM DIVERSION TUNNEL IN OPERATION



Diversion of water from the site of Owyhee dam, being built by the U. S. Bureau of Reclamation in eastern Oregon, was effected Aug. 7. These pictures show the intake and discharge ends of diversion tunnel in operation, the circular spillway shaft which is later to discharge through the lower portion of the tunnel, and the timber head-tower, rebuilt after its recent destruction by fire. The tower is to support one end of the cableway across the canyon. The diversion tunnel is 22 ft. in diameter.

Am.Soc.C.E. Meets in Boston October 9-11

Many of the papers scheduled for presentation at the fall meeting of the American Society of Civil Engineers, to be held in Boston, Mass., Oct. 9-11, will treat of engineering features of the Boston metropolitan district. Both the morning and afternoon technical sessions on Oct. 9 will be devoted to this subject, the presentation of which will be opened by a general paper on the development of the district by Frederic H. Fay, consulting engineer and chairman of the Planning Board of the City of Boston. Administration will be treated by Davis B. Keniston, chairman, Metropolitan District Commission; the park system by Edwin H. Rogers, director of park engineering for the commission; water supply by Frank E. Winsor, chief engineer, Metropolitan District Water Supply Commission of Massachusetts; transportation by a speaker to be announced later; and sewerage by X. Henry Goodnough, chief engineer, Massachusetts Department of Public Health.

On the following morning simultaneous sessions will be held by the city planning division and the structural division. At the former papers will be presented as follows: "The Plan of Boston, a Capital City," by Arthur C. Comey, landscape architect and consulting city planning engineer; "City-Planning Education for the Professional City Planner," by Henry Vincent Hubbard, professor of landscape architecture at Harvard University and vice-president of the American City Planning Institute; "City-Planning Education for Public Officials and the General Public," by Charles R. Gow, president, the Gow Company, Inc., and postmaster of the Boston district. The structural division will hear "The Lake Champlain Bridge, a Continuous Steel Truss Highway Bridge," by Charles M. Spofford, consulting engineer and professor of civil engineering at Massachusetts Institute of Technology; and "Research in Soil Mechanics at the Massachusetts Institute of Technology," by Glennon Gilboy, research associate at the Institute.

For the afternoon of Oct. 10 simultaneous meetings are scheduled for the power division, the highway division and the surveying and mapping division. At the power division meeting, Dr. Ing. D. Thoma, professor of hydraulics, water-power machinery and water-power plants and director of the hydraulic institute of the Technische Hochschule at Munich, Germany, now visiting professor at the Massachusetts Institute of Technology, will discuss the Kaplan turbines at the Ryburg-Schworstadt plant on the upper Rhine between Germany and Switzerland. A joint paper by George H. Henderson, chief engineer of the Rhode Island State Board of Public Roads, and Frederic E. Everett, state highway commissioner of New Hampshire, on "Equitable Distribution for Highway Purposes of Motor Vehicle License Fees and Gasoline Taxes," and a paper "Highway Beautification," by James H. Taylor, highway landscape supervisor, Palmer, Mass., will be presented before the highway division. Papers to be heard by the surveying and mapping division will be "Surveys for the Swift River Reservoir of the Boston Metropolitan District Water Supply" by N. Le Roy Hammond, division engineer of the Metropolitan District Water Supply Commission; "Leveling for Tunnels and Reservoirs for the Boston Metropolitan District Water Supply," by Laroy G. Harris, assistant engineer of the commission; and "Triangulation in Massachusetts and Its Connection With Land Court Registration," by Richard K. Hale, associate commissioner, Massachusetts State Department of Public Works.

In connection with the convention, a number of social events are scheduled, including an all-day motor trip along the Massachusetts coast to take place Oct. 11.

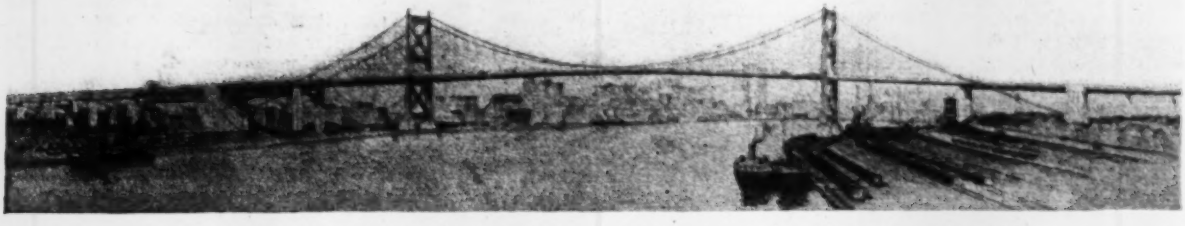
Toledo, Ohio, to Build 785-Ft. Suspension Bridge

Contracts have been awarded for the construction at Toledo, Ohio, of a 785-ft. suspension bridge across the Maumee River with a main span of 785 ft. and side spans of 233½ ft., flanked by approaches which will bring the total length of the structure between abutments to 901 ft. 9 in. There will be a 54-ft. roadway and two 6-ft. sidewalks paved with concrete, provision being made in the design for future asphalt paving. The suspension span will be of the usual parallel-wire type supported by steel towers with fixed ends. Foundations for the two main piers and the two anchorages will be based on rock, while the remainder of the structure will be carried on precast concrete piles. Each main pier will consist of two concrete caissons 28 ft. square, and each anchorage of two concrete caissons 22x96 ft. in plan. These are designed for sinking by open dredging or by excavating in the dry, but provision is made for using the pneumatic process if this proves necessary. Bedrock is about 60 ft. below water level, overlain by about 20 ft. of sandy clay which approaches hardpan in character. The rock is seamy and apparently carries some water under pressure.

Three contracts were awarded for the work as follows: main bridge substructure, H. P. Converse Company, Boston, $750,105; approach substructure, Holmes Construction Company, Wooster, Ohio, $209,565; superstructure, McClintic-Marshall Company, Pittsburgh, $1,645,882. The latter contract includes cables and concrete floors. The Holmes Construction Company has sublet the driving of the concrete piles for the approach to substructure to the Raymond Concrete Pile Company, New York City. The bridge is being built by the city of Toledo, with William H. Schroeder, director of public service, in direct charge. Waddell & Hardesty, New York City, in association with George Champe, of Toledo, Ohio, are consulting engineers. They have retained Leon Moisseiff as consultant and Cass Gilbert, Inc., as architect. C. K. Allen will be resident engineer of the bridge.

Contracts Awarded for Lighting Canadian Airways

Contracts have been awarded for lighting the Western Ontario Airways and the trans-prairie airway route for night flying, it is announced by the Department of National Defense at Ottawa. To the Canadian General Electric Company has been given the contract to supply and install five revolving electric airway beacons on the airway between Windsor, Ont., and Hamilton. The Highway Lighthouse Company receives the contract to supply and install eleven acetylene gas beacons between the same points. On the prairies the Canadian General Electric Company receives the contract for fourteen electric airway beacons mounted on 50-ft. towers, and the Highway Lighthouse Company the contract for 47 acetylene gas airway beacons. Under the terms of the contracts these beacons are to be installed on the airway between Winnipeg and Calgary via Regina, Moose Jaw and Medicine Hat.



PROPOSED 785-FT. SUSPENSION BRIDGE OVER THE MAUMEE RIVER AT TOLEDO, OHIO

Brief News

A NEW SEWAGE-DISPOSAL PLANT for Elyria, Ohio, costing $400,000, which will take care of the sewage for the entire city, has been put into operation.

POWER FROM COOLIDGE DAM WATER was used for the first time on Sept. 20. Recent rains filled the reservoir a month sooner than was expected.

THE NEW ROADWAY on the Quebec bridge was opened to traffic on Sept. 22, thus making a new link between the north and south shores. Heretofore it has been necessary to use ferryboats.

FORMAL DEDICATION of the new $1,200,000 Cedar Ave. bridge connecting Seven Corners with Tenth Ave. S. E., Minneapolis, Minn., took place on Sept. 29.

THE INDEPENDENCE-LIBERTY HIGHWAY BRIDGE over the Missouri River at Courtney, Mo., will be dedicated and opened on Oct. 11. This bridge, built at a cost of $1,000,000, will make a short cut from Lee's Summit to Liberty.

DEFEAT OF A BOND ISSUE by the voters of Jefferson County, Tex., on Sept. 19 for $4,000,000 to be spent on highways and $1,000,000 for a bridge across the Neches River is announced. The vote was close. The defeat of the proposition is attributed to the bridge item.

THE READING RAILROAD'S NEW STATION at North Broad St., Philadelphia, was opened on Sept. 30. The station, which cost $2,000,000, will be used for the transfer of main line and New York passengers.

BUFFALO'S NEW CITY HALL, which will cost $6,500,000, was started on Sept. 16, when the Mayor broke ground for the structure. It will be 32 stories high.

TESTING MODELS OF DAMS and other hydraulic structures will be facilitated by a flume recently installed in the new laboratories of the Carnegie Institute of Technology, Pittsburgh, Pa.

DWELLING HOUSES for the city of Paris are to be constructed as part of the German reparations payments. A Berlin firm recently received a contract for the construction of 3,000 dwellings to be completed in 1931.

COLOMBIA'S NEW WATER-WORKS in Barranquilla, which will supply that city with an abundant supply of river water, has been formally opened. The plant was constructed by an American engineering firm with funds provided by a loan raised in the United States.

THE WORLD'S FIRST CEMENT-TANK SHIP has been launched at Aalborg, Denmark, according to information received by the U. S. Department of Commerce. The ship is designed to carry 1,400 tons of loose cement in seven specially designed tanks, from which discharging will proceed through the medium of suction pumps.

WASHINGTON NOTES

By PAUL WOOTON
Washington Correspondent

Decentralization of Engineer Corps to Affect Only Major Projects — Illinois Waterway

DECENTRALIZATION of flood-control operations and inland waterway development will not tend in any way to diminish the authority of General Brown as Chief of Engineers, it has been asserted by the Secretary of War. The Engineer officers who will act as specialists in the field to supervise these operations will be responsible to General Brown and will report to him, Secretary Good pointed out. One of General Brown's first tasks will be to outline a program for the organization of the Corps of Engineers during his tenure as Chief. He also will be requested to make recommendations as to the officers whom he thinks most competent to take over the field work mentioned by the President. It has not been decided by the War Department as to what rank these assistants in the field will receive.

Only Special Projects Affected

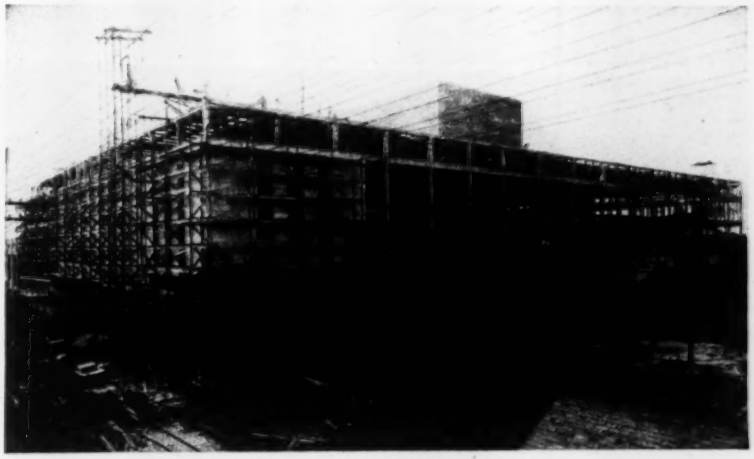
Secretary Good does not believe there is anything inconsistent with the previously announced intention of the administration of nominating a man of exceptional ability as Chief of Engineers, and the program of decentralization. He has expressed doubt that the decentralization will be extended to other projects before the War Department. In commenting on the situation, the Secretary pointed out that the flood-control work, the development of the inland waterways and the construction of a deep water route between the Great Lakes and the sea are special projects that call for special handling. The other activities of the Engineers are more or less regular in their requirements for supervision, he stated, and do not call for the detailing of specialists. By relieving the Chief of Engineers of direct responsibility for the major projects, it is believed that he will have more time to devote to formulating a general policy for the engineering activities of the government. War Department officials state that the decentralization program will be carried out with as little reorganization as possible. In all probability no new legislation will be required, it is said. It has also been stated that in carrying out the program nothing will be done to interfere with the work of the Mississippi River Commission.

Concerning the office of Assistant Chief of Engineers, Secretary Good has given indication that General Deakyne, the present Assistant Chief, will continue to occupy the office. It was observed by the Secretary, in this connection, that General Deakyne's tenure of office will continue for some time yet. He stated that the War Department is deeply appreciative of the excellent manner in which General Deakyne has discharged the duties of his office.

The Illinois Waterway

A report on the construction necessary to complete Illinois' section of the Lakes-to-the-Gulf waterway has been requested of the Engineer Corps, it has been stated by the Secretary of War. The purpose of this report is to obtain information to submit to Congress during the approaching regular session during the consideration of bills that will be introduced seeking to nationalize the portion of the waterway which has been left to the state to complete. It is explained by the Secretary that Illinois has about exhausted the $20,000,000 which was raised through a bond issue

BUILDING THE NEW ORLEANS MUNICIPAL AUDITORIUM



Construction of a $2,000,000 convention hall and municipal auditorium which will seat more than 10,000 persons is well under way in New Orleans, La. The building is to be 320x202 ft. and will contain the equivalent of five floors. There will be a two-story annex for display purposes for the use of such conventions as may bring material for exhibition.

to finance the work and that much remains to be done with no prospect of raising further funds.

Great Lakes Diversion

Should the United States take over this portion of the waterway, Secretary Good believes that it may result in placing army engineers in control of the diversion of water from the Great Lakes basin at Lockport. Without recourse to further legislation it is believed that the War Department, under the authority vested in it by the commerce clause of the Constitution, can proceed to divert sufficient water for navigation when the project is completed. It is also believed that the War Department, regardless of whether or not the entire project is nationalized, will give a liberal interpretation in deciding the amount of diversion necessary for navigation. In previous studies on this situation the engineers have indicated that in addition to the water directly needed for navigation, enough flowage should be included to prevent the upper portion of the waterway from becoming an open sewer, so that the health of those engaged in commerce shall be protected.

San Francisco Bridge Commission to Meet

The joint committee of army and navy engineers who will meet with representatives of the State of California to determine the practicability of constructing a bridge across San Francisco Bay and the effects such a structure would have on navigation will hold its first session in Sacramento Oct. 7. Army engineers designated to serve on the committee are Col. G. B. Pilsbury, district engineer at Philadelphia, and Major E. L. Daily, from the office of the Chief of Engineers. The navy will be represented by Admiral Luther E. Gregory and Admiral W. R. Stanley.

Personal Notes

M. W. TORKELSON, of Madison, Wis., representative of the engineering firm of Consoer, Older & Quinlan, has been appointed to the newly created position of regional planning director of the Wisconsin Highway Commission. Previous to 1927 Mr. Torkelson was state highway bridge engineer and later secretary of the commission, but resigned following the summary dismissal of John T. Donaghey in January, 1927.

BERTRAND H. WAIT, formerly Eastern manager of the Portland Cement Association, has resigned to become chief engineer of Curtiss Airports, Inc. He will be succeeded by J. R. FAIRMAN, formerly manager of the southeastern district office of the association at Atlanta.

W. B. WALRAVEN and C. C. WOOD, of Springfield, Ill., recently formed a partnership for the general practice of civil and structural engineering. Mr. Walraven will not take an active part at present, but will continue as engineer of the Springfield Sanitary District. Mr. Wood, who has been assistant engineer of the Springfield Sanitary District, will be in charge of the firm's activities.

HARVE N. CHINN, who has been with the engineering department of Hammond, Ind., for the past four years, has resigned to become an instructor in the civil engineering department of Rose Polytechnic Institute, Terre Haute, Ind.

HERBERT A. JACKSON, previously with the Western Gas Construction Company, Fort Wayne, Ind., as structural draftsman, has accepted a similar position with the Wisconsin Bridge & Iron Company, North Milwaukee, Wis.

J. E. NOLEN has been appointed division engineer of the Waco district of the Texas highway department, to succeed E. C. WOODWARD, who has resigned to become associated with a south Texas contracting firm.

R. L. PEARSON has been appointed chief engineer of the New York, New Haven & Hartford Railroad, succeeding Edward Gagel, who recently retired after 47 years' service with the road.

ROBERT L. HAMILL and DENNIS J. WALSH, JR., have been admitted to partnership in the firm of Sanderson & Porter, consulting engineers, New York City.

JACOB E. WARNOCK has left the U. S. Engineer office in Huntington, W. Va., where he was engaged on water-power investigations, and is now in the hydraulic department of the Aluminum Company of America, Pittsburgh, Pa.

ODON O. MELANCON, for the last six years in private business but before that for thirteen years in the U. S. Engineers' office in New Orleans, has been appointed assistant engineer of the Louisiana State Board of Engineers.

Society Calendar

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington; annual meeting, San Antonio, Tex., Nov. 12-15.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; annual convention, Biloxi, Miss., Nov. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; fall meeting, Boston, Mass., Oct. 9-11.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, Chicago; annual meeting, New Orleans, La., Oct. 15-17.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis; annual convention, Philadelphia, Pa., Oct. 14-18.

ASPHALT PAVING CONFERENCE, New York City; annual meeting, West Baden, Ind., Oct. 28-Nov. 1.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago; annual conference, Jacksonville, Fla., Oct. 14-16.

INTERNATIONAL CITY MANAGERS ASSOCIATION, Chicago; annual convention, Fort Worth, Tex., Nov. 20-23.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Washington; annual meeting, Chicago, Ill., Dec. 4-6.

SOUTHWEST WATER WORKS ASSOCIATION, Fort Worth, Tex.; annual convention, Tulsa, Okla., Oct. 14-16.

Obituary

F. B. LEOPOLD, of Pittsburgh, Pa., a filter-plant and water-purification manufacturer and engineer, died on Sept. 20 as a result of an automobile accident. Mr. Leopold went from Chicago in 1905 to Pittsburgh, where he became identified with the New York Continental Jewel Filtration Company and later became general manager of the Pittsburgh Filter Manufacturing Company. In 1912 he was made vice-president of the latter company and in 1922 he organized the F. B. Leopold Company and the Municipal Service Corporation, of both of which concerns he was president. He was 65 years old.

GEORGE ALFRED GOODENOUGH, professor of thermodynamics at the University of Illinois since 1911, died suddenly on Sept. 29. He was 61 years old. Professor Goodenough was graduated with the degree of bachelor of science from Michigan Agricultural College in 1891 and later did post-graduate work at the University of Michigan and the University of Illinois. The latter institution conferred upon him the degree of master of engineering in 1900. Among text books of which he was the author are "First Course in Calculus," "Principles of Thermodynamics" and "Properties of Steam and Ammonia."

THOMAS E. MITTEN, president of Mitten Management, Inc., and well-known street railway executive, was drowned in a fishing pond on his country estate near Milford, Pa., on Oct. 1. Born in Brighton, England, in 1864, he came to this country with his family in 1875. After several years of railway work as agent and train dispatcher Mr. Mitten became assistant superintendent of the city transportation system of Milwaukee, Wis., where his notable work in settling a serious strike lead to his advancement to general superintendent. In succeeding years he rehabilitated and reorganized transportation systems in Buffalo, Chicago and Philadelphia. Mr. Mitten was a pioneer in the development of profit-sharing plans for the benefit of employees of his companies.

CHARLES LINCOLN CARPENTER, of Andover, Mass., died on Sept. 28 while on a canoe trip in the Upper Gatineau district of Canada. Death was caused by a heart attack brought on by the strenuous journey through the wilds. Mr. Carpenter was 62 years old. He had held many important posts, including that of surveyor on the Nicaraguan Canal, assistant engineer with the Boston Board of Survey and engineer in charge of the Gatun dam and Porto Bello quarry on the Panama Canal. He had been identified with the construction of the Cuba Eastern Railway and for two years was superintendent of the Posce & Guayama Railroad. In 1911 he was elected vice-president and general manager of the Central Aguirre Sugar Company, Porto Rico. He was also vice-president and general manager of the Central Machette Company.

Construction Equipment and Materials

Reinforcing Steel Trade Rules Approved

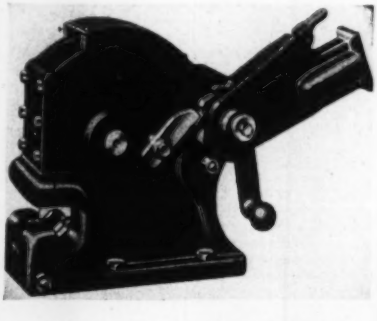
Resolutions offered by members of the reinforcing steel fabricating and distributing industry condemning unfair business practices, adopted at a trade practice conference held in Asheville, N. C., last April, have been acted upon by the Federal Trade Commission. The commission has affirmatively approved five rules and designated them "Group I" as applying to unfair methods of competition. Thirteen other rules were accepted by the commission as expressions of the trade and placed in Group II.

The Group I rules pertain to inducing breach of contract, misbranding, secret rebates, discrimination in price and commercial bribery. Group II rules include those applying to circulation of current price lists, manner of submitting bids for each job, dumping, arbitration, standard forms of contract for sales, departure from original agreements with respect to terms of discount for cash, discriminatory prices, reduced price in event of a market decline, uniform method of cost finding, proper marking and grading and provision that the trade practice conference be made a continuing organization to act for progressive elimination of unfair and uneconomic trade practices in the industry.

New Developments

Steel Band Used to Confine Ends of Cable When Cut

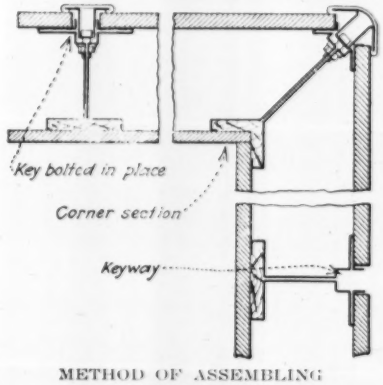
Use of a thin sheet of pliable steel manufactured by the Morse Starrett Products Company, Oakland, Calif., which is bent around a cable and fastened by means of a lock seam before cutting, results in a clean cut without flattening or displacing the strands of the cable. In operation, the cable with band attached is placed in a cutter and severed in the center of the band, leaving both ends bound. The company also makes a cable cutter which may be fastened to the floor or provided with a movable base, as desired, and is designed for both field and shop use. It operates on the ratchet lever principle, a cut being made with from three to seven strokes, and will take cable up to 1½ in. in diameter. Other models of the sledge type are available for field use.



CABLE CUTTER OPERATES ON RATCHET PRINCIPLE

Portable Buildings Designed for Easy Assembly

Unusual features of a new type of portable metal eating house developed for the White Castle System, Inc., Wichita, Kan., by Lloyd W. Ray, of the system's construction department, suggests the possible application of this type to other industrial and commercial uses. The company leases sites, and requires a building which shall be attractive in appearance, fireproof, easily assembled and dismantled, and sufficiently flexible in design that it can be adapted to the requirements of the particular site on which it is used. The structure now being used is made of porcelain enameled Armco ingot iron sheets secured without the use of rivets. The framework is made up of interchangeable sections the full height of the building built up by welding the studding into upper and lower tracks. Frames for windows, doors and transoms are bolted in and can be placed in any part of the structure. The sections are bound together and the exterior sheeting secured by a special key, as shown in the accompanying drawing. This key is covered by a white enameled sheet made to fit snugly over the flanges, leaving the exterior of the building without any evidence of the manner of fastening. Interior sheets are cut so that they meet at wood breaker strips inside of the studding. These strips, the only wood used in the building, serve as insulators between the two sheetings and also as a base for wood screws holding the interior sheets and nickel molding strips used to cover the interior joints. The final step in the building assembly is the filling of the space between the exterior and interior walls with asbestos rock wool insulation.



METHOD OF ASSEMBLING PORTABLE BUILDING

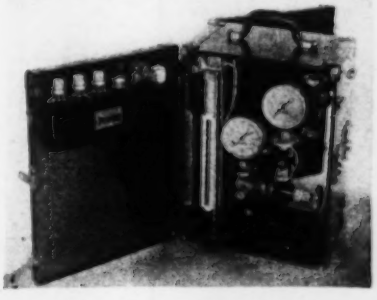
Concrete Roof Slabs Made With Light Aggregate

Less weight in the supporting steelwork used with concrete roof slabs is made possible by the Featherweight slabs now being manufactured by the Federal Cement Tile Company, Chicago, Ill. These retain the advantages of the older type of concrete roof slab—freedom from maintenance expense, fireproofness, imperviousness and strength—and at the same time result in more economical roof construction and greater insulating value. Roof units are made in a channel section with depths of 2¼ in. for spans of up to 6 ft. 8 in. and 3½ in. for greater spans. Webs are 1 in. thick. The material used is a 1:4 mixture of portland cement and Haydite aggregate. Each leg of the channel is reinforced with one deformed bar, and galvanized welded wire mesh reinforcing is used in the webs. For use where slate, ornamental tile or copper roofing is to be used, a 1½-in. thickness of nailing concrete is cast integral with the rest of the slab. Roof made of these units have a dead weight of only 10 lb. per square foot and will support a load of 60 lb. per square foot with a factor of safety of 4.

INSTALLING LIGHTWEIGHT CONCRETE ROOF SLABS

Changes Made in Portable Chlorinating Unit

Several refinements have been made in the design of the portable chlorinator produced by the Paradon Manufacturing Company, Arlington, N. J., the first model of which was described in our issue of June 13, 1929, p. 972. The ap-

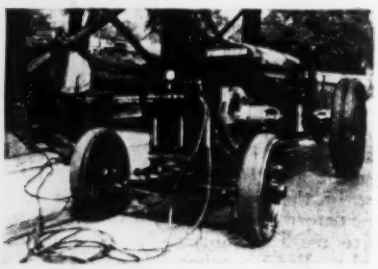


PORTABLE CHLORINATOR

paratus is now contained in a fiber case similar in construction to a piece of ordinary hand baggage, and a similar fiber carrier is provided for two small cylinders of chlorine with a capacity of 12 lb. each. Included in the outfit is a chlorine-testing outfit, spare parts, connection for the main and other necessary accessories. The unit will feed chlorine at rates varying from 1 lb. to 300 lb. per 24 hours, and equipment can also be supplied to decrease the minimum rate to 0.03 lb. per 24 hours. The feed is regulated by a complete standard dry-feed Paradon chlorinator, with a silver chlorine shut-off valve which makes it possible to keep the apparatus under pressure when not in use, thus preventing the entrance of moisture.

Tractor Frame Extended to Hold Welding Unit

A compact self-contained welding unit capable of moving under its own power at a road speed of 15 miles per hour has been assembled by the Pontiac Tractor Company, Pontiac, Mich. A Lincoln stable-arc welder on 200- or 300-amp. size is mounted on an extension of the frame of a McCormick-Deering tractor. This frame, made of 4-in.

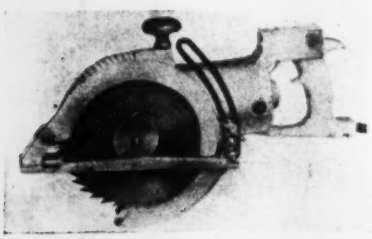


TRACTOR-MOUNTED WELDING UNIT

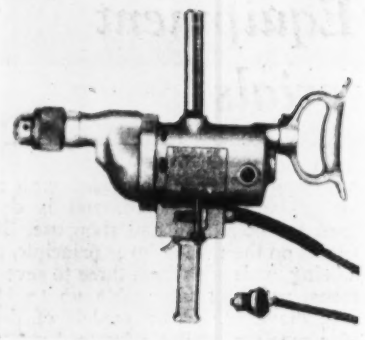
I-beams, reinforces the tractor and gives it balance, making it easy to steer with the added weight. The front axle is moved ahead under the frame extension, lengthening the wheelbase. Power to drive the welding unit is transferred from the tractor motor by means of a belt drive from the power pulley at the side.

Electric Drill and Hand Saw Made in Portable Size

Two light-weight tools for use on construction work where electric power is available have been brought out recently by the Wodack Electric Tool Corporation, of Chicago, Ill. The first



ONE-HAND POWER SAW



PORTABLE DRILLING MACHINE

of these, an all-purpose portable drill, will bore holes up to ⅝-in. diameter in steel and 2-in. in wood. It is powered by a General Electric motor using 110 or 220 volts a.c. or d.c., as desired. Current is controlled by a trigger switch in a convenient location in the handle. Ball and roller bearings are used, and quick cooling during idle running is assured by an oversize fan.

The second tool is an electric one-hand saw for cutting boards up to 2⅜-in. thickness. This, too, has the trigger switch, and is equipped with adjustable rip and depth gages and a sawdust blower to insure perfect vision. The unit weighs only 15 lb.

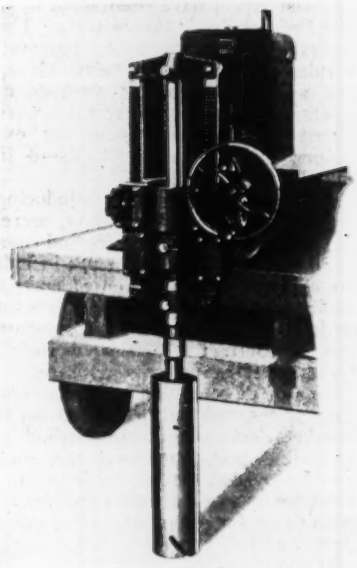
Core Drills Use Chilled Shot as Cutting Medium

For obtaining specimen cores from any material that will stand up under the process of coring, the Ingersoll-Rand Company, New York City, has developed a series of Calyx core drills utilizing chilled shot or crushed steel as the cutting medium in place of diamonds. Standard machines provide for cores ranging from 1½- to 11½-in. diameter, but larger machines are available to drill holes up to 36-in. diameter. Holes of different sizes can be drilled with the same machine, the only extra equipment needed being drilling tools. The company states that the Calyx drill will cut through both hard and soft material, among the harder rocks which it has penetrated being granite, taconite, jasper and corundum rock. In exploring for foundation purposes, the drills have also cut through old carwheels, structural steel shapes, car couplings and similar hard materials.

Power, supplied by gasoline engine, steam engine, electric motor or by hand, is applied to the drill rods at the surface through a core barrel to which the bit or cutter is attached. Water is pumped through the hollow drill rod and into the core barrel, passes under the bit and up through the annular space left around the core barrel by the clearance of the bit. Cuttings from the bottom of the hole are carried upward by the water to the top of the core barrel, where they settle on top of the plug. As these are deposited in the reverse order of penetration of the drill, this deposit constitutes a second or checking record of the materials passed through. The first, of course, is the core contained within the barrel.

Shot are supplied through a special connection, being carried to the bit, a few at a time, by the water current. For materials so soft that shot becomes bedded, better results are obtained by the use of steel cutters furnished with forged teeth. The latest in this type of bit is provided with removable inserted teeth which are sharpened on an ordinary emery wheel or grinder.

A special form of the Calyx drill has been developed for testing pavements.



SHOT DRILL FOR OBTAINING PAVEMENT SAMPLES

This machine has a standard size bit of 7½ in., but can be provided with 5½- or 6½-in. drills. Power is supplied by a 10-hp. two-cylinder gasoline engine. The entire outfit is mounted on a frame of structural steel ship channels which may be bolted to the body of any suitable truck.

New Publications

Hydro-Electric Construction—E. I. DU PONT DE NEMOURS & COMPANY, Wilmington, Del., is lending without charge a recently completed motion picture showing the development of the hydro-electric power project of the Carolina Power & Light Company in the Great Smoky Mountains of North Carolina. This is available in either 35-mm. or 16-mm. size.

Pig Iron—BETHLEHEM STEEL COMPANY, Bethlehem, Pa., has issued a revised edition of the Mayari pig iron book and also a 16-p. booklet "Silvery Mayari Pig Iron," discussing the composition, characteristics and uses of this metal.

Truck Cranes—UNIVERSAL CRANE COMPANY, Lorain, Ohio, in bulletin 47 explains methods of steel erecting, stone setting and rigging with the Universal truck crane. Many illustrations are included.

Crushing Plants—ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., has published a 90-p. booklet written in Spanish on modern rock-crushing plants.

Welding and Cutting Equipment—TORCHWELD EQUIPMENT COMPANY, Chicago, Ill., has published a 39-p. illustrated catalog of equipment for gas welding and cutting.

The Business Side of Construction

Weekly Lettings 20 Per Cent More Than a Year Ago

THE September contract total exceeds $300,000,000, as has that of every month this year. The weekly rate in millions of dollars was 81.3, compared with 70 in August and 71.3 a year ago. The average for the 39 weeks was 82.6, compared with 69 for 1928.

Engineering construction is 20 per cent ahead of last year. Other major business factors showing increases are new capital 36, electric power 12, bank debits 16, steel ingots 18. Figs. 1 and 2 show construction and check payments this year and last.

The gains are concentrated in the Middle Atlantic and Southern states, though decreases for this region are noted for Pennsylvania, the Carolinas, Kentucky and Tennessee. A little more than half of the total gain is in New York and New Jersey. Canada has gained 34 per cent. The standing of the principal regions as percentages of the total is as follows:

	1929 Per Cent	1928 Per Cent
New England	5.9	6.6
Middle Atlantic	41.2	37.7
South	9.0	7.5
Mid-West	19.8	24.2
West of Mississippi	14.9	14.8
Far West	9.2	9.2
United States	100.0	100.0

Large buildings account for two-thirds of the increase, all major classes contributing. The increase was 21 per cent; for other structures 18 per cent. Public works, amounting to a third of the total, gained 1.5 per cent. Fig. 3 shows cumulative road lettings. Though the year started slowly, considerable progress has been made in catching up, the deficit now being only 14 per cent, compared with 50 per cent at the end of the first quarter.

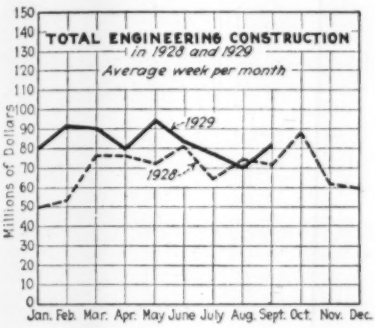

TOTAL ENGINEERING CONSTRUCTION
In 1928 and 1929
Average week per month
1929
1928
Millions of Dollars
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

FIG. 1—ENGINEERING CONSTRUCTION

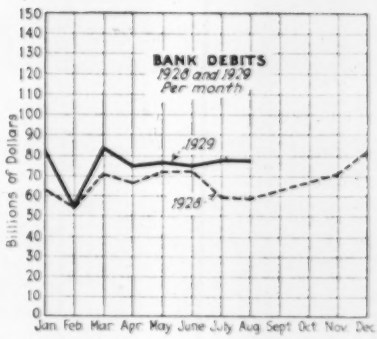


FIG. 2—BANK DEBITS

In the division of private construction, residential buildings have been the outstanding delinquent this year. This

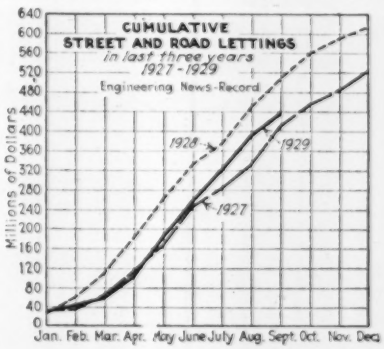


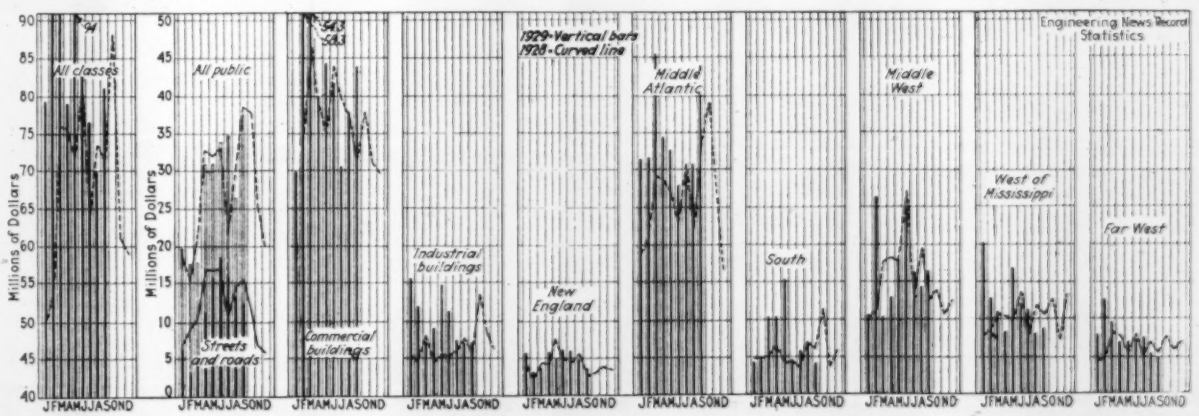
FIG. 3—STREETS AND ROADS

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, SEPTEMBER, 1929

Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States September, 1929	United States Year to Date 1929	United States Year to Date 1928	Canada September, 1929
Water-works	.....	$811	$34	$1,999	$775	$1,356	$4,975	$34,964	$39,828	$399
Sewers	$124	1,483	1,625	1,563	3,149	366	8,310	68,245	79,128	412
Bridges	1,119	2,735	443	3,974	1,586	3,770	13,627	110,425	93,710	680
Excavations, etc	44	252	910	3,097	1,071	179	5,553	24,928	30,053	915
Streets and roads	2,319	17,622	4,233	8,201	11,209	5,332	48,916	435,530	510,532	1,886
Industrial buildings	3,465	5,307	5,271	6,792	1,520	2,434	24,789	399,999	232,835	955
Commercial buildings	5,927	115,967	1,860	37,732	9,221	4,629	175,336	1,632,558	1,434,254	1,521
Federal government	148	1,906	1,461	909	2,510	500	7,434	90,146	53,490	.....
Unclassified	1,143	29,090	320	1,019	4,107	1,162	36,841	424,710	209,595	2,456
September, 1929*	14,289	175,173	16,157	65,286	35,148	19,728	325,781	.....	.....	9,224
August, 1929†	23,352	154,461	34,651	70,770	40,221	20,240	349,695	.....	.....	24,700
September, 1928*	10,955	134,554	24,792	51,501	41,250	22,159	285,211	.....	.....	10,149
Year to date, 1929	188,538	1,324,107	291,390	639,463	482,439	295,568	.....	3,221,505	.....	156,534
Year to date, 1928	176,466	1,012,394	203,344	648,183	396,475	245,963	.....	.....	2,682,825	117,153

*Four weeks. †Five weeks.



CONTRACTS AWARDED—AVERAGE WEEK PER MONTH—TOTAL U. S. BY CLASSES—ALL CLASSES BY SECTIONS

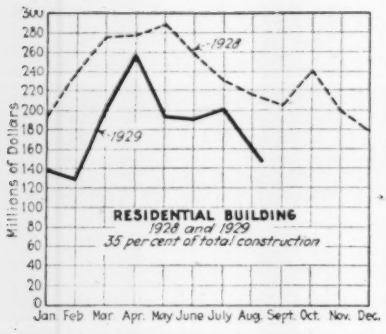

Millions of Dollars
1928
1929
RESIDENTIAL BUILDING
1928 and 1929
35 per cent of total construction
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

FIG. 4—RESIDENTIAL BUILDING

class has remained consistently under last year's curve, as Fig. 4 shows. Its ratio to total construction throughout the year has averaged 35 per cent and has been declining since June, the August figure being 30. The decline is 27 per cent under 1928 and 15 under 1927.

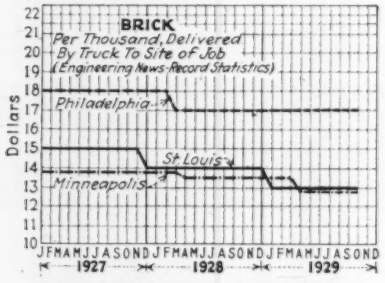
Materials Industries Try to Fit Supply to Need

The work of designing production to fit demand goes on. Brick and lumber were notably successful at it. The cement industry has not reefed sufficiently its generous capacity, and early last month suffered a sudden price cut of 10 to 20c.

Unprecedented steel demand this year seemed to remove the need for curtailment thinking in that industry. Mill operations have varied between 85 and 97 per cent, compared with 75 to 81 in 1928 and 65 to 83 in 1927. Since Aug. 3, however, the rate has been steadily declining from 96 to 85 in the week of Sept. 21. In an effort to renew demand or at least to prevent a continuing decline, prices have been reduced $1 per ton on bars and shapes and $2 on wire rods. "It would not be surprising," says the Pittsburgh correspondent of *Iron Age*, "if steel operations declined a bit further in the next month or two in order to bring about a better adjustment of production to demand."

The Sept. 1 statement of the Common Brick Manufacturers' Association of America takes a gloomy view. On July 1, 1925, there were 66 plants operating in the Hudson River district; 36 have closed, and the remainder easily supply greater New York. There were 5,083 men emeployed; four years later 2,981, and today 2,000. The reasons given for this "demoralization" are imports and less construction.

On the matter of imports the association points out that the loss to manufacturers does not go into the pockets of the building public. All brick in the metropolitan area is sold through dealers, and it is they who profit from the lower price. It is important to note, also, that imports to New York have been declining in the last four years: from 101,946,000 in 1926 to 76,034,000 in 1928. For the first seven months of 1929 they total 12,587,000, compared with 52,502,000 in that period of 1928. Domestic brick moved from yards in New York, New Jersey, Maryland and Delaware in August amounted to 62,162,000.



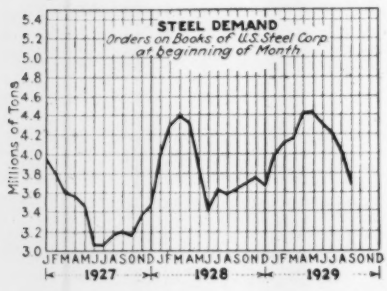
BRICK PRICES, THREE YEARS

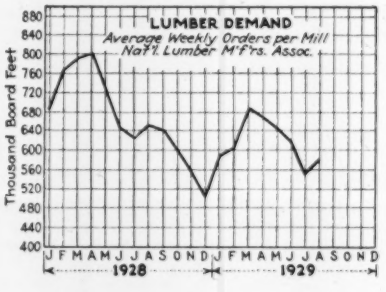
With respect to construction in New York and New Jersey, contract letting is 18 per cent under last year, due entirely to a 33 per cent decline in residential building. For New York City, although building plans filed in the first eight months total $799,843,000, compared with $715,656,000 the year before, during the last four months there was a severe drop.

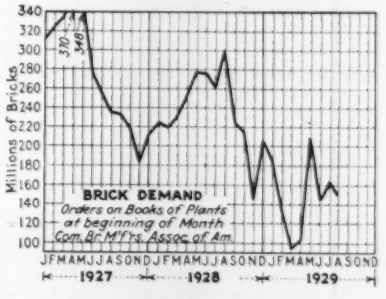
The lumber industry, which until a month ago has consciously observed a restrictive policy, seems to have abandoned it. In the first two weeks of September production increased 1½ per cent over a year ago despite the fact that orders were declining 16½ per cent. With unfilled orders 9 per cent less than last year, mill stocks are 2 per cent larger.

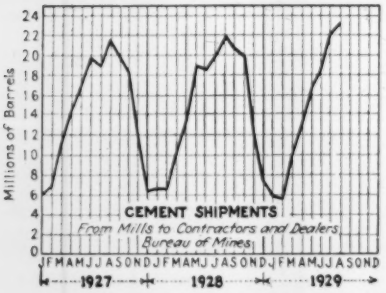
The cement industry has 25 per cent more capacity than it needs to supply the maximum demand. Consequently, unless quotas are observed, competition will run high and prices weaken, as happened a month ago. While another price cut of this importance is not looked for, adjustments are still taking place among the dealers. Foreign cement is another factor in the unstable situation.

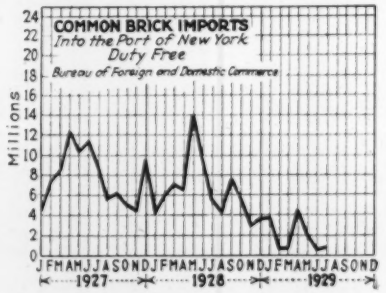
In this matter of an industry organizing itself and controlling its output, copper has made considerable progress. Since peak output in April there have been four reductions in the average daily rate. This was possible through closer association. According to the Guaranty Trust Company bulletin, "Four companies are now believed to control 52 per cent of the total smelter output." This curtailment of production has held the price at 18c. during the recent slow market. The control extends to the fabricating industry. The producers control much of the wire and brass capacity of the country.

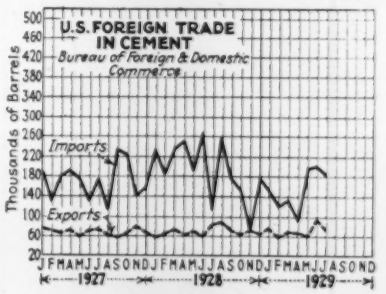












DEMAND FOR BASIC CONSTRUCTION MATERIALS AND IMPORTS OF CEMENT AND BRICK

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**; declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor*
Atlanta	$1.25@1.40	$0.60@.70	$0.60@1.00	$0.50		$0.75@1.25	$0.25@.35
Baltimore	1.75	1.00@1.10	1.00@1.37½	.65	$1.00	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50		1.25	.20 @ .35
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45 @ .80
Cincinnati	1.62½	1.40	1.40	1.00	1.40	1.40	.40 @ .60
Chicago	**1.70**	**1.62½**	**1.62½**	**.97½**	**1.62½**	1.62½	**.97½**
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	1.67½	1.12½	1.25	**.50** @ .75	1.25	1.25	**.35**@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00		1.25	.37½@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.37½@.60
Kansas City	**1.50**	**1.37½**	**1.37½**	.90	1.25	1.25	.40@.75
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75		1.00	.40@.60
Montreal	1.25	.80	.75		90	1.00	.30@.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.87½	1.65	1.92½	1.18¾	1.10@1.23¾	1.92½	1.03
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½		1.50	.40@.80
St. Louis	1.75	1.50	1.50 @1.65	1.15@1.25	1.25	.62½	.40@.87½
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.50	1.12½	1.25	1.00	1.12½	1.25	.70

*Minimum rates are for construction other than buildings, non-union.

Where the Short Week Is; Local Conditions

Despite all the talk there has been of the five-day week, it has not been put into practice very widely. In the construction industry—where acceptance of it has been greatest—one or more trades have won it in 130 cities. Following is a summary of a survey of the subject by the Builders' Association of Chicago:

Trades	No. of Cities Having Five-Day Week
Plasterers	42
Painters	34
Lathers	25
Plumbers	25
Bricklayers	21
Electrical workers	20
Carpenters	15
Iron workers	14
Sheet-metal workers	10

New York—Charges have been brought by the carpenters' union against local subway contractors, that the prevailing wage clause of the labor law is not being observed. Testimony brought out at the hearing revealed that men had been employed to do carpenter work at 80c., as against the official rate of $1.50. Some of the men declared they accepted the lower rate because of inability to obtain employment at $1.50. About 100 rockdrillers and helpers on the Yonkers-Long Island water tunnel struck Sept. 24 for advances of $3 per day.

Buffalo—Carpenters claim city is not paying prevailing rate of wages in this trade. Craftsmen declare that two years ago the schedule was advanced from $1.12½ per hour to $1.25 and that carpenters on municipal jobs continued to receive the old rate.

Boston—Steamfitters' helpers struck Sept. 14 for advance of 10c., to $1.05. Carpenters struck Sept. 19 as result of jurisdictional dispute with the ironworkers over setting of metal window-frames. Unemployment, while severe in this district, is much worse in Fall River, Holyoke, New Bedford and Salem. Six trades now have the five-day week—namely, electricians, lathers, painters, plasterers, plumbers and steamfitters.

Philadelphia—Jurisdictional dispute between carpenters and ironworkers over steel partition work. Unemployment continues severe, although there are more plans out for estimate.

Washington—Painters signed an agreement Sept. 13 for an advance of $1 ($11) and five days.

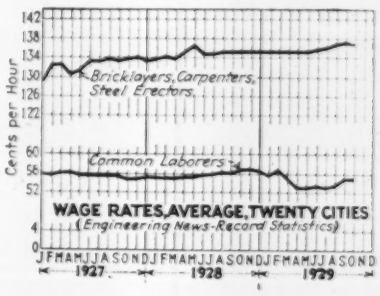
Pittsburgh—Building trades mechanics went on strike Sept. 7 against employment of men from other cities at less than the local scale. After tying up all work on public projects, operations were resumed pending further negotiations.

Atlanta—Carpenters reported working 20c. below scale at 40@50c. per hour. In almost any city this trade is in at least advantageous position.

Dallas—Bricklayers' scale $1.75, from $1.67½, Dec. 1. Carpenters receive five-day week Jan. 1. All trades will probably be on shorter week by March, with some increases in rates.

Chicago—New wage schedule for building trades mechanics effective Oct. 1. Bricklayers advanced 7½c. ($1.70); carpenters, hoisting engineers, pile-drivers, 6½c. ($1.62½); hod carriers, 7½c. (97½c.); common laborers, 2½c. (97½c.). Lathers granted five-day week and advance of 60c. per day ($13.60); same for plasterers' laborers ($8.30), without shorter week. Only painters, plasterers and lathers have five days.

Kansas City—Twelve building trades ask five-day week with commensurate wage advance, for March 1. Building laborers ask higher wages only. Bricklayers and hoisting engineers advanced 12½c., to $1.50 and $1.37½, respectively.



Denver—Bricklayers are 85 per cent employed. This craft is about the busiest of the building trades, with carpenters next, at 60 per cent employed.

Montreal—Poor harvests in the West kept laborers in the city with resulting oversupply.

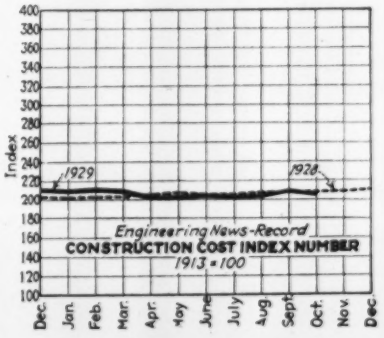
Skilled building trades mechanics receive an average rate of $1.36⅜ per hour, compared with $1.37 in September and $1.35⅛ a year ago. The skilled rate in manufacturing is 66.1c.

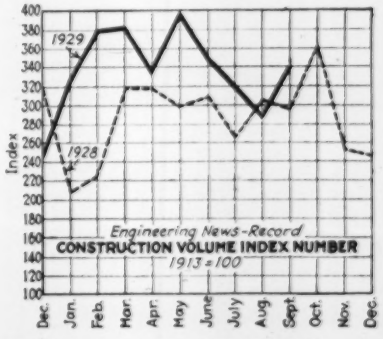
Common laborers average 54.96c., the same as last month. The rate a year ago was 56.28c. The average unskilled rate in manufacturing is 50.1c. per hour.

Construction Cost and Volume Index Numbers

E. N.-R. Cost		E. N.-R. Volume*	
Oct., 1929	**206.32**	**Sept., 1929**	**340**
Sept., 1929	207.57	Aug., 1929	290
Oct., 1928	207.71	Sept., 1928	296
Peak June, 1920	273.80	1928 (average)	287
1928 (average)	206.78	1927 (average)	263
1913 (average)	100.00		
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299
June	206.15	June	308
July	206.65	July	266
August	207.29	August	306
September	207.29	September	296
October	207.71	October	363
November	209.46	November	251
December	210.16	December	244
1929		1929	
January	209.46	January	325
February	210.40	February	378
March	207.78	March	382
April	203.40	April	332
May	205.15	May	395
June	205.65	June	347
July	204.77	July	320
August	205.91	August	290
September	207.57	September	340

*Corrected for price change since 1913.





ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per barrel, *without charge for bags*, cash discount not deducted. Prices marked f.o.b. are manufacturers'; others are delivered by truck to contractors.

	Oct. 3, 1929	One Month Ago	One Year Ago
Atlanta	$2.35	$2.35	$2.30
Baltimore	2.40	2.40	2.65
Birmingham	*2.50*	2.60	2.60
Boston	*2.10@2.25*	2.25@2.35	2.35
Cedar Rapids (f. o. b.)	2.04	2.04	2.24
Chicago (f. o. b.)	1.85	1.85	2.05
Cincinnati (f. o. b.)	1.92	1.92	2.22
Cleveland (f. o. b.)	1.94	1.94	2.24
Dallas	2.15	2.15	2.15
Davenport (f. o. b.)	2.04	2.04	2.24
Denver	2.61	2.55	2.85
Detroit (f. o. b.)	1.95	1.95	1.95
Duluth (f. o. b.)	1.84	1.84	2.04
Indianapolis, (f. o. b.)	1.89	1.89	2.19
Jersey City	2.60	2.60	2.35
Kansas City, Mo.	2.65	2.65	2.20
Los Angeles	2.42	2.32	2.66
Milwaukee (f. o. b.)	2.00	2.00	2.20
Minneapolis (f. o. b.)	2.02	2.02	2.22
Montreal (f. o. b.)	1.70	1.70	1.41
New Orleans	2.65	2.65	2.40
New York	2.10	2.10	2.25@2.35
Peoria (f. o. b.)	2.02	2.02	2.22
Philadelphia	*2.30*	2.40	2.41
Pittsburgh (f. o. b.)	1.85	1.85	2.04
St. Louis	*2.20*	2.45	2.45
St. Paul (f. o. b.)	2.02	2.02	2.22
San Francisco	2.41	2.41	2.41
Seattle	2.70	2.70	2.70
Toledo (f. o. b.)	2.03	2.03	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Lehigh Valley District	$1.45
Buffington, Ind.	1.60	Limedale, Ind.	*1.60*
Clinchfield, Ga.	1.65	Mason City, Ia.	*1.60*
Hannibal, Mo.	*1.80*	Norfolk, Va.	1.90
Houston, Tex.	1.95	North Birmingham, Ala.	*1.20*
Hudson, N. Y.	1.55	Richard City, Tenn.	*1.55*
Ironton, Ohio	1.50	Steelton, Minn.	1.65
Iola, Kan.	*1.65*	Universal, Pa.	1.60
La Salle, Ill.	*1.70*	Wyandotte, Mich.	1.70

SAND AND GRAVEL—Dealers' quotations per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds.

	Gravel, 1½ In.	Gravel, ¾ In.	Sand
Atlanta, per ton	$2.65	$2.65	$2.00
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb.)	3.00	3.00	2.65
Boston, per ton	1.90	1.90	1.25
Chicago	1.90	1.90	1.80
Cincinnati, per ton	1.65	1.65	1.40
Cleveland (3,000) (2,700)	2.60	2.60	2.50
Dallas	*2.70*	*2.70*	*2.50*
Denver (2,700 lb.)	1.80	1.80	1.30
Detroit (2,600 lb.)	3.25	3.25	2.75
Kansas City, Mo.	2.00	2.00	2.00
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.) (3,000 lb.)	2.40	2.40	1.10
Montreal, per ton	*1.25*	*1.25*	1.25
New Orleans (2,700 lb.) (2,500 lb.)	3.75	3.75	2.75
New York	3.25	3.25	2.00
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	**2.20**	**2.20**	**2.40**
St. Louis, per ton	2.25	2.25	2.00
San Francisco (2,800 lb.)	1.75	1.75	1.50
Seattle (3,200 lb.) (2,850 lb.)	1.75	1.75	1.75

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Dealers' quotations per cu.yd., delivered. Weight, 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$2.65	$2.65
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.25	2.25
Chicago, Limestone (2,500)	1.90	1.90
Cincinnati, per ton	2.25	2.25
Cleveland, per ton (2,500)	2.70	2.70
Dallas	3.25	3.40
Denver, Granite (2,700 lb.)	2.50	2.50
Detroit, Limestone, per ton (2,500)	3.00	3.00
Kansas City, Limestone	2.00	2.00
Los Angeles, per ton	2.15	2.15
Minneapolis, Limestone (2,600 lb.)	2.40	2.40
Montreal, per ton	2.10	2.10
New York, Limestone	3.25	3.25
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton, (2,400 lb. per cu.yd.)	1.95	1.95
San Francisco, Trap rock (2,400 lb.)	1.65	1.65
Seattle, (2,700 lb.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	¼-In.	½-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.15	1.15	.....	.80
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Dealers' quotations on hollow building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.072	$0.099	$0.135	$0.181	$0.202
Baltimore	.105	.....	.20	.....	26
Birmingham	.09	.127	.174	.218	.261
Boston	**.086**	.115	.155	**.19**	**.26**
Chicago	.076	.104	.142	.182	.202
Cincinnati	.066	.09	.125	.16	.18
Cleveland	.064	.088	.128	.171	.19
Dallas	*.095*	*.11*	*.17*	*.221*	.....
Denver	.0975	.135	.175	.2125	.25
Detroit	.098	.135	.184	.24	.265
Kansas City	.0525	.077	.158	.22	.242
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0611	.081	.10605	.1302	.1737
Montreal	.12*	.....	.22†	.....	.....
New Orleans	.086	.118	.16	.212	.256
New York	.0864	.1296	.162	.....	.....
Perth Amboy, N.J. (f.o.b.)	.....	.....	.....	.2388	.2956
Philadelphia	.105	.14	.215	.28	.34
Pittsburgh	.068	.....	.1175	.....	.1726
St. Louis	.078	.104	.145	.175	.21
San Francisco	.108	.156	.255	.....	.....
Seattle	.085	.115	.18	.....	.....

*4x4x12. †8x8x12.

BRICK—Dealers' quotations, delivered, per thousand are as follows:

	Common	Paving, 3x8½x4-in.	Paving, 3½x8½x4-in
Atlanta	$13.50	$38.00*	$45.00†
Baltimore	14.00	40.00	46.00
Birmingham	15.00	30.00*	34.00†
Boston	16.50	**43.50**	48.00
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	14.50	35.00	.....
Denver	11.00	.....	.....
Detroit	15.50	34.50	38.50
Kansas City	**14.50**	.....	.....
Los Angeles	12.00	.....	.....
Minneapolis	12.75	.....	.....
Montreal	20.33	.....	.....
New Orleans	16.50	40.00*	50.50
New York	14@15	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	*16.00*	40.50	45.00
St. Louis, salmon	13.00	*36.00*	*40.00*
San Francisco	14.50	40.00	45.00
Seattle	14.00	50.00	55.00

*2¼x8¼x4 in. †3x8¼x4.

LIME—Dealers' quotations, delivered to job:

	Hydrated, per Ton—Finishing	Hydrated, per Ton—Common	Lump, per Barrel—Finishing	Lump, per Barrel—Common
Atlanta	$21.00	$13.50	.....	.....
Baltimore	**22.00**	14.00	$2.55†	.....
Birmingham	22.00	16.00	3.00†	**$2.00†**
Boston	21@**22**	**14.75**	**4.00***	**3.00***
Chicago	18.00	14.00	18.00‡	1.35†
Cincinnati	15.30	12.70	.....	.....
Cleveland	20.00	16.00	2.50†	2.50†
Dallas	20.00	.....	.....	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	16.00	12.50	2.75†	2.50†
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	19.75	.....	.....	15.00‡
New Orleans	.....	.....	2.60†	1.60†
New York	21@23	14@15	4.10@4.20	3.15@3.25*
Philadelphia	22.00	15.00	.....	.....
Pittsburgh	21.00	19.00	2.50†	.....
St. Louis	24.00	18.00	2.75†	15.00‡
San Francisco	27.50	20.00	.....	1.70†
Seattle, paper sacks	36.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.17@.20	Minneapolis	$0.15
Brooklyn and Queens	.12@.14	New Orleans	.22
Cleveland	.16@.17	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, f.o.b., quarry, Bangor, Pa., net, per square:

No. 1 Clear	$9.45@$13.05
No. 1 Ribbon	8.10@ 9.23
Medium Clear	8.55@ 10.13

Road and Paving Materials

PAVING STONE—Dealers' quotations, f.o.b., in carloads or in cargo lots, for granite blocks, 4x8x4-in., dressed:

Atlanta	$3.00 per sq.yd
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.15 per sq.yd.
Minneapolis, Sandstone, 4½x8x5 in.	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd.	150.00 per M.
Philadelphia	125.00 per M
St. Louis, 4x5x8 to 12 in.	3.50 per sq.yd.
San Francisco, Basalt block, 4x7x8 in.	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Dealers' quotations, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2 25
Boston	3½	16	2 55
Chicago	3½	12	2 10
Cincinnati	3½	16	2 35
Dallas	3½	18	3 90
Kansas City	3½	16	2 75
Minneapolis	3½	16	2 75
Montreal	4	16	4 50
New Orleans	3½	16	2 50
New York	3½	16	2 70
St. Louis	3½	16	2 30

FLAGGING—Dealers' quotations, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBING—Dealers' quotations: *New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16 in., f.o.b., $1.00 per lin.ft.; roundings, $1.50 per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	$20 40	$16 40
Baltimore (Standard Oil, f.o.b. refinery)	21 75	17 75
Birmingham (Mexican)	27 00	23 00
Boston (Mexican)	23 50	18 00
Chicago (Texas)	23 50	19 30
Cincinnati (Kentucky Rock)	.....	12 30
Cleveland	24 00	20 00
Dallas (Texas)	**27 37**	.....
Denver (California)	35 00	.....
Detroit (Mexican)	19 72	15 69
Kansas City, Mo. (Texas)	27 30	**23 00**
Los Angeles ("D" Grade, California, f.o.b., El Segundo)	18 00	12 00
Maurer, N. J. (Bermudez)	30 00	.....
Maurer, N. J. (Trinidad)	25 00	.....
Minneapolis, (Stanolind, f.o.b., Twin Cities)	24 10	19 10
Montreal (Imperial)	28 00	21 50
New Orleans (Texas)	24 00	21 00
New York (Texas)	22 50	18 50
Philadelphia (Mexican)	18 00	15 00
Pittsburgh (Standard Oil)	24@26	14@18
St. Louis (Mexican)	21 50	17 50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18 00	12 00
Seattle, ("D" grade, California)	**24 40**	.....

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0 0525
Birmingham, 50@60% asphalt	0525
Dallas, 40@50% asphalt	**0625**
Dallas, 50@60% asphalt	**0625**
New York, 40@50% asphalt (at terminal)	.05
New York, 50@60% asphalt (at terminal)	.05
St. Louis, 40@50% asphalt	0342
St. Louis, 50@60% asphalt	0357

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$14.00@$14 50
Pittsburgh, basic, incl. freight ($1.76) from Valley	20.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	*3.45*	*3.45*
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (Sept. 26, 1929)	*1.90*	1.95
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.15	3.15

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.15@3.00
Cleveland, warehouse, delivered	2.25@2.44
Dallas, warehouse, delivered	*3.25*
New York, warehouse, delivered, over 5 tons	2.90
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.05
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Dealers' quotations per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	¾ Bir-mingham	Chicago	St. Louis	Dallas	San-Francisco
2.2	**$18 50@$20 00**	**$27 00**	**$25.50**	**$23 00**	**$28.50**	**$29.50**
2.5	**19 50@ 21.00**	**28 00**	**26.50**	**24 00**	**30.00**	**30 50**
3.0	**21.00@ 22.00**	**30 00**	**28.00**	**26 00**	**32.00**	**33 00**
3.4	**23 00@ 23 50**	**31 50**	**29.00**	**27 00**	**33 50**	**35.00**

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and dealers, delivered in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pitts-burgh Mill	Chicago District Mill	Warehouse Delivery— New York	St. Louis	Dallas	San Fran-cisco
032	22	$0.99	$1.01	$1.39	$1.45	$1.13	$1.22
049	28	1.26	1.29	1.76	1.80	1.38	1.55
068	35	1.54	1.58	2.18	2.25	1.67	1.91
093	40	1.98	2.03	2.79	2.90	2.00	2.46
126	57	2.45	2.51	3.45	3.55	2.55	3.03
153	68	2.92	2.99	4.13	4.25	3.15	.....
180	78	3.35	3.43	4.73	4.85	3.47	.....

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base:

	Blue Annealed No. 10 *	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$4.05	$4.90
Cleveland, warehouse, delivered	3.25	3.90	4.75
New York, warehouse, delivered	3.90†	4.00	4.75
Pittsburgh, large mill lots, f.o.b.	2.10@2.20	2.85	3.50@3.60
St. Louis, warehouse, delivered	3.45	4.25	5.10
San Francisco, warehouse, delivered	3.80	4.90	5.30

*Light plates †Up to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	50%
Special and extra strong cast steel, round strand rope	27½%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, round-head, ½-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	$4.00
Dallas, warehouse, delivered	4.00
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b.	3.10
St. Louis, warehouse, delivered	**4.15**
San Francisco, warehouse, delivered	5.65
Seattle, warehouse, delivered	5.00

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill:

Per package	$11.20

SHIP SPIKES—Dealers' quotations per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Dealers' quotations per 100 lb. keg, base, delivered from warehouse stocks, also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.45@$2.55	$3.30	$3.20	$2.95	**$3.85**	$3.35	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$12.00@$12.50	**$15.75@$16.25**	$14.50
Stove plate	8.00@ 8.50	13.50@ 14.00	9.00
No. 1 machinery cast	12.50@ 13.00	*15.50@ 16.00*	**13.85***
Machine shop turnings	*7.75@ 8.00*	8.00@ 8.50	*8.00*
Cast borings	7.00@ 7.75	10.25@ 10.75	*7.50*
Railroad malleable	14.00@ 14.50	17.00@ 17.50	13.50
Re-rolling rails	**13.25@ 13.75**	*17.50@ 18.00*	.....
Re-laying rails, 56@60 lb.	23.00@ 24.00	23.00@ 25.00	.....
Heavy melting steel, No. 1	*12.75@ 13.25*	*14.75@ 15.25*	*14.00*
Iron and steel pipe	10.75	10.50@ 11.00	8.75@ 10.50

*Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71†
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15*		

*Minimum weight on structurals, 60,000 lb. †Except iron or steel pipe and fittings.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mill lots:

	Pitts-burgh	Birming-ham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34.00	34@36	34@36

RAILWAY TIES—Dealers' quotations, f.o.b., for fair-sized orders:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	**1.18**	*1.44*
	Red oak, creosoted	**1.55**	*1.96*
San Francisco	Sap pine or cypress, untreated	**.91**	1.20
	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.60

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb. f.o.b., Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅜-in. and larger	$2.80	$3.55	$3.50	$3.65@$3.85	$3.85
Track bolts	3.80	4.55	4.50	4.65@4.85	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.50		

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers standard lists:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$40.00@$41.00	$37.00@$38.00
Burlington (N. J.) mill	38.00	35.00
Chicago	48.20@49.20	47.20@46.20
New York	40.60	37.60
Pittsburgh	48.50@49.50	45.50@46.50
St. Louis	45.60@46.60	42.60@43.60
San Francisco	50.00@51.00	47.00@48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Dealers' quotations, delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.13½	$0.22½	$0.75				
Baltimore		.30	.58		$1.93		$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.185	.30	.55	1.325	2.20	3.60	6.00
Chicago	.15	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.135	.21	.405	1.25	2.025	3.67	5.74
Cleveland	.18	.294	.567	1.35	2.43	4.824	7.38
Dallas	.256	.42	.79	1.70	3.00		
Denver	.161	.23	.414	.816	1.44		
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52		1.90	3.80	
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.84	3.49	4.97
Montreal	.36	.53	.78	1.48	2.75	4.20	
New Orleans	.195	.325	.585	1.10	2.11		
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.05	1.89	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.137	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.26	2.16	3.60	
Seattle	.22	.30	.54	1.26	2.16	3.60	

CLAY DRAIN TILE—Dealers' quotations, delivered, per 1,000 lin ft.:

Size, In.	New York	Birmingham	St. Louis	Dallas	San Fran.	Seattle
4	$55.00	$56.00	$50.00	$63.00	$67.50	60.00
6	112.00	112.00	85.00	110.00	112.50	112.00

Miscellaneous

LINSEED OIL—Dealers' quotations on raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York....**$0.166** Chicago....**$0.173** Minneapolis....**$0.173**

WHITE AND RED LEAD—Dealers' quotations per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.75; Red, dry, $13.75; Red, in oil, $15.25.

CHEMICALS—Water, sewage treatment, road work, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	6.00@ 6.10
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, cylinders, per lb.	.05@ .08
Bleaching powder, in drums, f.o.b. works, per 100 lb.	2.00@ 2.10
Calcium chloride, in drums, f.o.b. works, per ton	20.00

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¾-in., 8-ft.; ¾-in., 6-ft.; 1-in., 4½-ft.; 1-in., 3½-ft.; 1¼-in., 2-ft., 10-in.; 1½-in., 2-ft. 4-in. Following are dealers' quotations per pound for ¾-in. and larger, delivered in 1,200-ft. coils:

Atlanta	**$0.228**	Kansas City	$0.25
Baltimore	.225	Los Angeles	.25
Birmingham	.26	Minneapolis	.24
Boston	.225	Montreal	.245
Chicago	.22	New Orleans	.25
Cincinnati	.21	New York	.215
Cleveland	.21	Philadelphia	.24
Dallas	**.21**	San Francisco	.205
Denver	.24	Seattle	.205
Detroit	.23½	St. Louis	**.235**

BUILDING PAPER—Black, in carloads, per roll of 500 sq.ft., f.o.b., producing point $2.08

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.91½

ROOFING MATERIALS—Dealers' quotations, f.o.b., New York, to contractors in carloads:

Asphalt felt, per 100 lb.	$2.60
Tar felt, per 100 lb.	2.60
Asphalt coating, per gal.	.34½
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFINGS—Dealers' quotations to contractors, in carloads, f.o.b. New York, per square:

Single shingles, slate finish, sufficient to cover 100 sq ft.	$6.15
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouse:

AA 83% A 86% B 88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2325
Baltimore	.215	.2375	Minneapolis	.2275	.2525
Birmingham	.22	.245	Montreal	.195	.22
Boston	.22	.25	New Orleans	.195	.22
Chicago	.195*	.22*	New York	.255‡	.2775‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.1875	.23	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.1725

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

New York—Timbers, rough, delivered to contractor at site of job, in 20 ft. lengths and under, per M. ft., b.m.:

	Merchantable Long-leaf Yellow Pine	No. 1 Common Douglas Fir
3x4 to 8x8	$55.00	$43.00
3x10 to 10x10	65.00	43.00
3x12 to 12x12	75.00	44.00
3x14 to 14x14	87.50	50.00

Chicago—Dealers' quotations, f.o.b., in carloads, No. 1 common, rough, per M ft. b.m. For delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$43.00	$42.00
3x10 to 10x10	50.50	42.00
3x12 to 12x12	62.50	42.00
3x14 to 14x14	74.50	43.00

San Francisco—Dealers' quotations on rough Douglas fir, No. 1 common, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Other Cities—Dealers' quotations, delivered, No. 1 Common, rough, per M. ft:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$55.00				$65.00	
Baltimore	36.00	$50.00	$53.50	$61.00	75.00	$50.25
Birmingham	45.00				60.00	
Boston	48.50	47.00	47.50	48.50	58.00	52.00
Cincinnati	52.50	62.50			70.00	57.50
Cleveland	65.00	65.00			65.00	65.00
Dallas	65.00	57.50	57.50	55.00	65.00	57.50
Denver		57.00	57.00	55.00		55@58
Detroit	58.75	**50.00**			68.50	**50.50**
Kansas City, Mo.	50.00	50.00			56.00	56.00
Los Angeles		44.00				44.00
Minneapolis	58.00	53.25	38.25‡		58@60	53.25@54.75
Montreal	50.00	55.00			50.00	48.00
New Orleans	50.00	46.00		44.00	67.00	63.00
Philadelphia	52.00	44.00	44.00	50.00	62.00	43@45
Pittsburgh	65.00	70.00	75.00	65.00	65.00	65@72
St. Louis	**49.00**	**45.00**			**61.00**	**44.00**
Seattle		**24.00**				**24.00**

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00			$42.50	
Baltimore	56.00	$45.00	$45.00		
Birmingham	36.00			43.00	
Boston	45.00	43.00	**42.50**	48.50	$47.50
Cincinnati	65.00	57.50		42.00	55.00
Cleveland	60.00	55.00		65.00	58.00
Dallas	60.00				
Denver		44.00	46.00		50.00
Detroit	45.00	**43.00**		**48.00**	**45.00**
Kansas City, Mo.	50.00	**47.00**		**47.00**	**47.00**
Los Angeles		38.00			57.00
Minneapolis	53.00	47.00	39.75‡	51.00	46.00
Montreal	56.00	48.00	40.00		
New Orleans	43.00	40.00		50.00	46.00
Philadelphia	53.00	44.00	42.00	57.00	45.00
Pittsburgh	50.00	60.00	59.00	42.00	
St. Louis	**45.00**	**42.00**	**41.00**	**41.00**	**39.00**
Seattle		**21.50**			23.00

*Long-leaf yellow pine. †Douglas fir. ‡F.o.b.

PILES—Dealers' quotations per lineal foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	36
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.33	.41
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.38	.41